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WHAT HAS HAPPENED TO PHYSICAL GEOGRAPHY?

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Dedicated to the Memory of R D CALKINS
April 20, 1873—September 27, 1955

AT the time when the Association of American Geographers was founded, physical geography was the most prominent part of earth-lore in instruction and in the writings that were labeled "geography." The meaning given to the term "physical geography" had, it is true, been modified in the preceding fifteen years, almost entirely through the efforts of the founder of the Association, William Morris Davis. A decade earlier Davis had imposed on all but one of his fellow-members of the sub-committee on geography of the Committee of Ten on Secondary School Studies his then novel conception of its content.[1]

Before about 1890 there was no evident disagreement about what physical geography was. The most succinct definition given in the textbooks is Russell Hinman's of 1888: "Physical geography seeks to trace the operation of the laws of nature upon the earth; upon the air, the water, and the land; upon plants, animals, and even upon man."[2] This definition, except for the reference to man, was one that Humboldt would have subscribed to. Its derivation was clear: it could be traced back through Humboldt, Bergman, and Lulofs to Varenius; and from Varenius to the encyclopedic writers of the Middle Ages, who built on Aristotle.

The notion of physical geography embodied in the recommendations made to the Committee of Ten in 1893 differed from Hinman's only in giving primacy to the surface of the lands, in the spirit of Davis's concepts, over the atmosphere and the oceans. This "curious and persistent insistence on the peculiar claims of physiography" was one of the points at which the dissident Houston directed his opposition. But the spirit of the study of the earth that Davis recommended for secondary schools was the same as the one that animated the instruction in physical geography at Harvard in which he had participated for twenty years, the same that Hinman had expressed. That is to say, the earth was approached from the viewpoint of the physical and natural sciences; it was studied in its own terms and for its own sake.

[1] National Education Association, *Report of the Committee of Ten on Secondary School Studies* (New York, 1894), pp. 204–240. The lone dissenter was Edwin J. Houston.

[2] *Eclectic Physical Geography* (New York, 1888), p. 2.

The textbook by Davis's student R. S. Tarr[3] that was published two years later is written in the same spirit.

PHYSICAL GEOGRAPHY UNDER DAVIS'S DOMINATION

But at some time in the middle of the eighteen-nineties Davis shifted from this position, in which the earth is studied on its own account, to the one he retained to the end of his life. The earliest record of this shift I have found was published in 1897, but must have been written no later than early 1896.[4] Here Davis presents, as one of the goals of public instruction, the imparting of "a clear understanding of the manner in which our mode of living is related to the earth on which we live. . . . From the time of the first occupation of the State its people have been constantly influenced . . . by the geographical features that they observed about them. . . . The pupils should therefore be led . . . to perceive the character of the various geographical influences by which settlement, occupation, etc., have been determined." The duality of the content of geography that Davis asserted so frequently in his later writings appears distinctly in a statement made in 1897,[5] in which he appeals to the memory of Ritter and Guyot and to the contemporary Ratzel in support of a definition of geography as "the study of the earth in relation to man." His definition of "one part of geography, which is coming to be called physiography," sounds the note that was long to echo in geographic writings: "everything about land, ocean and atmosphere that constitutes an element of man's environment is . . . a subject for physiographic study."

It is a tribute to Davis's industry and persistence that this curiously oblique motivation of the investigation of a great class of natural phenomena was accepted, apparently without serious questioning. It dominates Davis's own textbook published in 1896,[6] as it does the books written by others but modeled after his.[7] It is appealed to in the great books written for use in the universities by R. D. Salisbury and R. S. Tarr.[8] In these great manuals, motivation by an appeal to geography as concerned "with the distribution and associations of life (including human industries) as affected by physical conditions" (Salisbury) or "with the influence of the surface features [of the earth] on human and other life, and the interaction and interrelation between air, water, land, and life" (Tarr) was superfluous. Both books contain statements about the influence or relations of physical features on or

[3] *Elementary Physical Geography* (New York, 1896).

[4] William Morris Davis, "The State Map of Massachusetts as an Aid to the Study of Geography in Grammar and High Schools," [Massachusetts] *State Board of Education, 60th Annual Report*, pp. 482–500. Citation from p. 496.

[5] The Present Trend of Geography," *University of the State of New York, 111th Annual Report*, 1898, pp. 192–202.

[6] Davis, assisted by William Henry Snyder, *Physical Geography* (Boston, 1898).

[7] Only one needs to be cited: Charles R. Dryer, *Lessons in Physical Geography* (New York, 1901).

[8] Rollin D. Salisbury, *Physiography* (New York, 1907, 1919); Ralph Stockman Tarr, *College Physiography* (New York, 1914), published under the editorial supervision of Lawrence Martin.

with human life and economy, better and fuller in Tarr than in Salisbury. But these statements are uttered merely in passing; the overwhelming bulk of both books is devoted to the straightforward discussion of the physical features of the earth, precisely as if these were being investigated for their own sake.

It can scarcely be supposed that the uncritical references to "influences" or "relations" written into the books published in the first two decades of this century were any more satisfactory to their authors than they are to us today. What gives them their gratuitous quality is that before 1890 the physical earth could be discussed without self-consciousness, without any appeal to its supposed "influences" on human affairs. It is only in the United States, to the best of my knowledge, that geographers have not felt free to investigate the physical features of the earth's surface without looking anxiously over their shoulders to see whether these features affect human beings in some way.

I can offer no explanation why Davis set the example of insisting that the earth's physical features, though they were to be investigated according to the same general methods as other natural phenomena, should be looked upon, not as in themselves appropriate objects of scientific inquiry, but as the objects of one of the two divisions he saw in geography, for one of which he accepted Huxley's term "physiography" in a distorted sense, and for the other invented his stillborn term "ontography." There can be little doubt, however, that he implanted in American geography the anxiety about what geography is that has not only spawned numerous definitions, but has also hampered straightforward work in physical geography.

It is well known that in his original work Davis paid little attention to the limitations that in his theoretical utterances he imposed on physical geography. Occasionally, in fact, he expressed the impatience I have displayed here: ". . . it is not altogether clear why geographers are so generally content to leave to geologists all treatment of matters so eminently physiographic as the weathering of rocks, the wasting of soils, the transportation of land waste by streams, the abrasion of land margins by the waves. If these activities had occurred only in the remote past, geologists alone might lay claim to them; but, as a matter of fact, they are all part of the very living present."[9] It was under Davis's stimulation that work in physical geography became a self-evident task of candidates for advanced degrees. Moreover, he was a strong advocate of studies of regions. As early as 1894 he urged that monographs on the individual states be written under the auspices of the state geological surveys.[10] The first such work, on Missouri, was by his student Marbut;[11] but the Davisian ideal was probably more closely approached by the younger Cleveland Abbe's memoir on Maryland.[12] In his old age Davis recalled

[9] "Practical Exercises in Physical Geography," *Proceedings*, New York State Science Teachers Association, 5th Annual Conference, 1900, p. 6.

[10] "Physical Geography in the University," *Journal of Geology*, Vol. 2 (1894), pp. 66–100. Reference to p. 99.

[11] C. F. Marbut, "Surface Features of Missouri," *Missouri Geological Survey Report*, Vol. 10 (1896).

[12] Cleveland Abbe, Jr., "A General Report on the Physiography of Maryland," *Maryland Weather Service*, Vol. 1 (1899), pp. 41–216.

these writings and others of the same class to the members of the Association,[13] but they have been largely overlooked, as has also his elaborate treatise on the description of regions published in 1915.[14] Though in his programmatic writings Davis made physical geography no more than one member of an ill-matched pair, by his original work and his guidance of students he maintained for it an independent place in science.

DAVIS'S YOUNGER CONTEMPORARIES

When in 1924 Davis reviewed the progress of American geography, his view of geography in general, except for the assertion that the description of regions is its ultimate goal, was the same as he had urged two decades earlier. Though he did not realize the fact, he was speaking to a generation that knew him not. The theoretical structure of geography he had built up at the turn of the century had become obsolete. Probably his best exposition of that structure was published in 1902:[15] "Let it then be here agreed that the whole content of geography is the study of the relation of the earth and its inhabitants. We thus see two prime divisions of the subject. One includes all the physical environment of life; the other all those responses which life has made to the environment. . . . It is the element of relationship between the physical environment and the environed organism, between physiography and ontography . . . that constitutes the essential principle of geography today."

By way of defining what he meant by "establishment of relations," Davis was wont to use an expression borrowed from Arnold Guyot: "rising to the causes and descending to the consequences." In what he considered the essential relations in geography, this meant rising to the physical causes and descending to the organic consequences of terrestrial phenomena. For him, as for most nineteenth-century rationalists, the "organic" included the psychologic and social as well as the physiologic. Davis's theory of the intellectual function of geography thus rested on the presumption of an unbroken chain of causation linking the physical phenomena of the earth's surface, the organic realm, and human society. This monistic and mechanistic interpretation has deep roots in Western thought, but acquired special emphasis in the late nineteenth-century through the extension of the Darwinian concept of evolution through natural selection to the intellectual and social realm. Davis, like his teacher N. S. Shaler, but within a narrower intellectual frame, repeatedly confessed the "evolutionary" basis of his thought.

It is ironic that precisely in the years when Davis was maturing at Harvard a group of thinkers at the same institution was tearing down the intellectual structure that Herbert Spencer and the social Darwinists had erected.[16] By the turn of the

[13] W. M. Davis, "The Progress of Geography in the United States," *Annals*, Association of American Geographers, Vol. 14 (1924), pp. 159–215. Reference to p. 195.

[14] "The Principles of Geographical Description," *Ibid.*, Vol. 5 (1915), pp. 61–105.

[15] "Systematic Geography," *Proceedings of the American Philosophical Society*, Vol. 41 (1902), pp. 235–259. Reference to p. 240.

[16] Philip F. Wiener, *Evolution and the Founders of Pragmatism* (Cambridge, Mass., 1949).

century, when Davis's influence was rising to its peak, mechanical, monistic interpretation was outdated in psychology, anthropology, and economics. It was rendered obsolete by the recognition that in human societies processes of an order different from the mechanical order are at work, processes that cannot be comprehended even by the categories applicable to organic phenomena. Those who were remaking psychology, economics, and anthropology, warned by the errors into which mechanical interpretations had led, were cautious. They proceeded empirically and were reluctant to generalize.

This is not the place for comment on the anomaly that environmentalism burgeoned in American geography at a time when specialized students of cultural phenomena had abandoned it. But it is necessary to note the consequences for physical geography of the attrition of the environmentalistic dogma. That such an unlikely effect supervened resulted from the original assertion of a causal concatenation between the physical and the cultural. When the link of assumed causation between these sets of incommensurable phenomena was finally recognized as being hopelessly weak, the two halves of Davis's structure of geography fell apart, and the two sets of phenomena toward which it was directed retained only their empirical association in space. But the concatenation assumed earlier had a lasting effect through the selection of the individuals who were to carry American geography into its post-Davisian stage. To uncritical minds the linkage of physical cause with cultural effect offered an explanation of cultural phenomena, which were included in the body of facts at the end of the Davisian chain of causation. The impression that geography offered an explanation of matters relating to human beings attracted to it more adherents with a primary interest in finding explanations of historical events than with a curiosity about the physical earth. The copious writings of Miss Semple, for example, whose interests lay wholly within the "human" part of Davis's "ontography," attracted many who would have been repelled by the soberer investigations a Davis or a Salisbury pursued in his original work.

The change in character of the papers read at the meetings of the Association of American Geographers during the first twenty years of its existence has often been remarked upon. It consisted, of course, in a progressive concentration of attention on "human" affairs, accompanied by at least a relative reduction in the number of papers dealing with the physical earth. Programs of the meetings show that this change was scarcely if at all a result of change in the interests of the original members, who continued to report on matters they had always been interested in. The significant change was in the identity of the persons who read papers: an increase in the number of academic instructors in geography at the expense of persons engaged in various fields of investigation concerned with the earth but not self-conscious geographers, whom Davis's hospitable conception of the membership appropriate to the Association had attracted to it. These new participants customarily laid their offerings on the altar variously inscribed on its several faces: "control," "influence," "adjustment," and "relation."

It was mainly academic geographers who contributed the answers cited by G. B. Roorbach in his report of 1914 on the results of an inquiry concerning "the three most important problems that need solution, or the three most important lines of investigation that need to be followed, in the subject of geography."[17] Only two out of 29 whose replies Roorbach reported, W. W. Atwood and N. M. Fenneman, listed problems in physical geography. The task most frequently cited was a more explicit formulation of "geographic influences" than was available. The majority of Roorbach's correspondents had gone far beyond Davis's definition of only a decade earlier. They had moved from Davis's position at the node between physical and organic facts, from which one might follow the physical facts back to their causes and forward to their consequences. They had taken a position much farther down the stream of causation, and were interested only in tracing cultural facts back to their physical causes, back to the node that in Davis's mind was the home base of the geographer.

In their relation to the future, several of the replies Roorbach's inquiry elicited attract attention by "[placing] investigations on regional geography among the most important." In answers written from Chicago appear expressions that later were to become familiar: "comparative studies of different regions" (Tower); "type studies," "standardize methods of investigation and of writing" (Barrows). These expressions, Davis's exposition of regional description published in the following year but written in 1913,[18] and Fenneman's presidential address of 1918, "The Circumference of Geography,"[19] heralded the new definitions that were to appear after the interlude of the first world war. Fenneman's interpretation of the content of geography was more generous than was to be heard in most comparable utterances in the future. It was left to his successors to draw the circumference of geography with a radius so small as to exclude parts of geography, such as geomorphology and climatology, that lay within that circumference as he drew it.

NEW DEFINITIONS IN THE TWENTIES

Environmentalism was not abandoned completely until the late nineteen-twenties, but it was in retreat through most of that decade. The first of the new definitions of geography to attract attention was the one H. H. Barrows gave in his presidential address of 1922.[20] His title was innocent enough; for at least fifteen years geography had been defined in ecologic terms, and Barrows was probably not far wrong in ascribing to American geographers a definition of "their subject as dealing solely with the mutual relations between man and his natural environment." One might question some of these words: "solely," for example, and "mutual"; Roorbach's correspondents had not been quite unanimous, and a long

[17] G. B. Roorbach, "The Trend of Modern Geography: A Symposium," *Bulletin of the American Geographical Society*, Vol. 46 (1914), pp. 801–816.

[18] "Principles of Geographical Description," *op. cit.*

[19] Nevin M. Fenneman, "The Circumference of Geography," *Annals*, Association of American Geographers, Vol. 9 (1919), pp. 3–11.

[20] "Geography as Human Ecology," *Ibid.*, Vol. 13, pp. 1–14.

time had passed since any geographer had said much about man's effect on the earth.[21] The term "ecology" had become familiar at about the beginning of the century, and it was inevitable that someone would apply it to the relations claimed by so many geographers as their particular concern. J. P. Goode had so applied it in 1907, describing a course given at Chicago as "essentially an elementary course in plant, animal and human ecology."[22] But what concerns us is the content that Barrows gave the term "human ecology" as a synonym for "geography." His definition is perhaps the most drastic example in our literature of definition by exclusion. He disposed of the components of physical geography one by one, concluding thus: "In short, geography treated as human ecology will not cling to the peripheral specialisms to which reference has been made—to physiography, climatology, plant ecology, and animal ecology—but will relinquish them gladly to geology, meteorology, botany, and zoology, or to careers as independent sciences."[23] Barrows not only shortened the radius of the circumference Fenneman drew about geography; he also shifted its center. His circumference is drawn eccentrically in Fenneman's figure, so as to exclude "physiography" (that is, geomorphology), climatology, and biogeography, but to include some "systematic" constituents, namely, economic, political, and a potential social geography.

In the perspective of thirty-odd years Barrows' proposals can be seen to be closely related to what had preceded them. He conceived the earth as "environment" rather than as an entity worthy of attention for its own sake. Moreover, he confessed an all but absolute economic determinism, operating in the true mechanical spirit of social Darwinism: "I believe that . . . upon economic geography for the most part the other divisions of the subject must be based" (p. 13).

Carl Sauer's programmatic statement of the following year[24] shows the same eccentricity in relation to Fenneman's circumference as Barrows' definition. But he recognized that the "social sciences" had abandoned their search for "laws." Their "a priori principles," he wrote, "are being discarded under a recently developed agnosticism. . . . They are relying now upon the historical method of tracing the growth of institutions, on statistical correlations and their interpretation, and even introducing various survey methods." Sauer thus rejected definitely the hypothesis of mechanical causation in human affairs that had so long afflicted American geographic thought. The positive proposals he made were probably too inclusive an application of experience gained in a special situation—the situation that gave rise to the Michigan Land Economic Survey—but they had a

[21] R. S. Tarr, in his *Elementary Physical Geography,* had included a chapter "Man and Nature," the title of which echoed that of George Perkins Marsh's great work, and the first part of which dealt with man's modification of nature.

[22] J. Paul Goode, "A College Course in Geography" (abstract), *Annals,* Association of American Geographers, Vol. 1 (1911), p. 111.

[23] Barrows thought, however, that knowledge of these fields was "an indispensable prerequisite to successful geographic work."

[24] "The Survey Method in Geography and Its Objectives," *Annals,* Association of American Geographers, Vol. 14 (1924), pp. 17–33.

prodigious influence in the following years, providing a pattern for innumerable studies of small areas. Physical geography, which Sauer distinguished sharply from "physiography," was basic to his program. It is selective, "selecting those items that represent the background and the medium of human activities, as it were, the human habitat" (p. 27). But physical features are to be classified genetically if possible. The "facts of occupation," the elements of the cultural landscape, are to be ordered according to the ethnic origin of the inhabitants and the history of settlement. The principle that comprehension of phenomena is to be sought in terms of the phenomena themselves was thus respected in Sauer's "survey method," though the method and its purposes were anthropocentric.

In his "Morphology of Landscape"[25] Sauer rejected the rational interpretation of physical forms. He could not "relinquish," as Barrows had, the investigation of land forms and climate, soils and vegetation, since to him the object of inquiry was not an abstract "relation," but the material landscape. He retained title to them, instead, by dividing the lore of land forms and of the atmosphere into two phases, one empirical and the other rational. Thus he was able to claim for geography an empirical physical geography as opposed to a rational "physiography" in Huxley's sense.

After this theoretical preparation, the description of "regions" became, in the nineteen-thirties, the standard kind of geographic writing in the United States. But we did not achieve the substantial monographs of the French and German type that had been held up as examples. Davis's students had come closer to that ideal a generation earlier. Instead, Sauer's suggestion that "perhaps a township, or a county, is a better field for testing research ability in geography than a state or a great region"[26] was accepted with blind literalness; the mapping of the two phases of the land surface in a small area became the typical academic specimen of aspirants to degrees in geography. The elaborate intellectual structure set forth in "The Morphology of Landscape" was degraded to the bare bones of the existing economy of small regions. Most American geographers succumbed to what the late Harold Innis called "the obsession with the immediate."[27] I am speaking here of the innumerable accounts of "regions" turned out according to a perfunctory scheme that demanded no more than a moderate amount of diligence. Programmatic utterances made a place for "systematic" inquiries concerning the physical earth, provided these acknowledged their subservience to regional description, as twenty-five years earlier they had been forced into a subordinate place as expositions of environmental controls.

Two generations of American geographers thus renounced what in the latter part of the nineteenth century had seemed their most obvious task. The motivation of this renunciation is obscure; but its method, the selection of disciples and suc-

[25] "The Morphology of Landscape," *University of California Publications in Geography*, Vol. 2 (1925), pp. 19–53.

[26] "Survey Method," *op. cit.*, p. 32.

[27] J. H. Willits, in "Harold Adams Innis, 1894–1952," *American Economic Review*, Vol. 43 (1953), pp. 1–25. Reference to p. 13.

cessors by influential personalities in American geography, is fairly clear. Its characteristic manifesto was the restrictive definition of geography.

THE CONTEMPORARY SITUATION

Fortunately, practice never quite fulfills the expectations of prescription. Despite the efforts of those who would reduce the investigation of the surface of the earth to a barren inventory of its commercially valuable resources and the marks of their exploitation, an intellectual concern with the traditional content of geography for its own sake has persisted among us. It is a hopeful sign that one of our best publishing houses has issued an expensively produced textbook bearing the simple title "Physical Geography,"[28] whose author frankly invokes the great books by Salisbury and Tarr as his models.

Much of Davisian geomorphology had become stale and unprofitable before its author's death. But the multitudinous forms of the land surface remain, as accessible to new insights as to Davis's. Investigation of them has lagged. The literature of theoretical and experimental hydrology abounds in suggestions that have never been taken out of the hydraulic laboratory and applied to the surface of the land. More has been learned in the last twelve years about the behavior of surface waves in water than by earlier investigators since Newton; but no one has systematically walked the shores of our seas and lakes seeking to apply these theoretical and experimental results to the forms exhibited there.

With respect to the atmosphere we have been more fortunate, since climatology has not been completely divorced from a rational meteorology. If in the last quarter-century a gap has yawned between geographers and meteorologists it is not because of ignorance on the geographic side that the meteorologists were remaking their science, but of unwillingness to learn the rigorous language the meteorologists use. Such indolence exposes us to the indignity Werner Baum has inflicted upon us by making an invidious distinction between "meteorological" and "geographical" climatologists.[29] We forfeit our claim to respect if we accept that distinction, or admit, as has recently been done, that what the meteorologists write is "beyond the intellectual reach of the geographer."[30] What they write about is our concern, from the transfer of heat and water vapor at the earth's surface to the systole and diastole of the westerlies.

If our physical geography is to become something more than elementary instruction in matters that are not normal objects of investigation by the instructors, the shackles that have long hampered us must be struck off. I mean restrictive definitions, first imposed by William Morris Davis. I venture the guess that one reason why our colleagues in other countries have found satisfactory work in physi-

[28] Arthur N. Strahler, *Physical Geography* (New York, 1951).

[29] Werner A. Baum, "Accrediting Problems in Meteorology," *Bulletin of the American Meteorological Society*, Vol. 34 (1953), pp. 319–320.

[30] Arthur N. Strahler, "Empirical and Explanatory Methods in Physical Geography," *The Professional Geographer*, Vol. 4 (1954), pp. 4–8. Reference to p. 6.

cal geography to a greater extent than we have is that they have not been hampered by such definitions.

At the present juncture we should be better off without a sharply formulated definition. It would be good if we could again approach the earth with unhampered curiosity and attempt to satisfy that curiosity by whatever means the problems we encounter suggest. In particular, we should discard a restriction that has long been laid upon us: the prohibition of concern with processes. Let processes be restored to the central position they deserve: physical processes in physical geography, historical processes in cultural geography. Let us resume the fresh and frank quest that Hinman announced nearly seventy years ago: "to trace the operation of the laws of nature upon the earth." The land, the sky, and the water confront us with questions whenever we look at them with open eyes. These questions, and the privilege of sharing in the quest of answers to them, are a part of our birthright.

SOME PROBLEMS IN THE DISTRIBUTION OF GENERIC TERMS IN THE PLACE-NAMES OF THE NORTHEASTERN UNITED STATES*

WILBUR ZELINSKY

Chesapeake and Ohio Railway Company

FOR many years American toponymy has been the domain of students of language who have been concerned almost exclusively with specific names.[1] There is much in the best of such research to interest geographers, but the even more promising topic of generic terms—the common nouns—used to denote geographic features in the United States has been strangely neglected by geographers and linguistic specialists alike.[2] As major items in any cultural landscape, these terms deserve close scrutiny for their own sake; but of even greater importance are the complex, uncharted inter-relationships among place-names and other phases of culture and the possibility that their study may illuminate significant aspects of American cultural history and geography.[3]

It is the purpose of this exploratory essay to survey the distribution of a selected group of generic terms over an important section of the United States, to speculate about their significance, and to note some of the problems to be encountered in their further study. The fact that several hundreds of thousands of place-names exist in the United States has made it necessary to limit this reconnaissance to a single major region immediately productive of challenging facts and problems—

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[1] All except the most recent materials on the subject are listed in Richard B. Sealock and Pauline A. Seely, *Bibliography of Place Name Literature, United States, Canada, Alaska, and Newfoundland,* American Library Association (Chicago, 1948). Much of the more important work is summarized in George R. Stewart, *Names on the Land* (New York, 1945) and in H. L. Mencken, *The American Language* (4th ed.; New York, 1947), and *The American Language, Supplement II* (New York, 1948).

[2] Some pioneering essays were written by geographers early in this century, but they failed to stimulate further investigation. The most important of these are Herbert M. Wilson, "A Dictionary of Topographic Forms," *Journal of the American Geographical Society,* Vol. XXXII (1900), pp. 32–41, and R. H. Whitbeck, "Regional Peculiarities in Place Names," *Bulletin of the American Geographical Society,* Vol. XLIII (1911), pp. 273–81.

[3] Interesting work along these lines, based chiefly on specific elements in place-names, is reported in Alfred H. Meyer, "Toponymy in Sequent Occupance Geography, Calumet Region, Indiana-Illinois," *Proceedings of the Indiana Academy of Science,* Vol. LIV (1945), pp. 142–59, and H. F. Raup and William B. Pounds, Jr., "Northernmost Spanish Frontier in California as Shown by the Distribution of Place Names," *California Historical Society Quarterly,* Vol. XXXII, No. 1 (1953), pp. 43–48.

specifically the Northeastern United States—and to a single readily accessible source of data—the large-scale topographic sheets of the Geological Survey and the Corps of Engineers. It is recognized that such an approach represents a crude compromise between two earlier types of studies, both conducted in considerable depth: the analysis of a single term over its entire range in time and space[4] and the intensive inventory of all specific and generic terms within a restricted territory.[5] Obviously, the ultimate synthesis of American place-name study will require a great many more monographs of both types. The utility of the present paper lies in its providing a rough scaffolding that may somehow indicate the shape of the final edifice, or at least afford the builders an overview of their task.

LIMITATIONS OF THE STUDY IN TERMS OF AREA, TOPIC, AND SOURCE MATERIALS

The area encompassed by this study (shown in Fig. 1) is that contiguous and more or less compact territory in the Northeastern United States for which topographic sheets of a scale of 1:62,500 or larger were available in 1953. Fortunately, this region happens to include the sites of the earliest permanent European colonization in the United States (except that in Florida) and also constitutes an area that furnished settlers to most of the rest of the nation. In addition to being a culture hearth, the Northeastern United States is also characterized by a degree of cultural diversity well above the average for the country, and is rivalled in this respect perhaps only by Louisiana.

Specific terms were eliminated as a topic of study and also such generic terms as are applied casually in vernacular speech to features of the landscape without being incorporated into particular names, e.g., such usages as *rise, dip,* or *neighborhood.*[6] In other words, only those generic terms appearing on topographic maps as a portion of a geographic name have been studied. Their number has been further reduced by the omission of terms describing the internal features of towns,

[4] Robert C. West, "The Term 'Bayou' in the United States: A Study in the Geography of Place Names," *Annals*, Association of American Geographers, Vol. XLIV, No. 1 (1954), pp. 63–74.

[5] The most outstanding example is Frederic G. Cassidy, *The Place-Names of Dane County, Wisconsin,* Publications of the American Dialect Society, No. 7 (Greensboro, N. C., 1947), a study based not only on written and cartographic sources but also on painstaking field work. Among the more important studies based largely, if not entirely, on documentary materials are George Davis McJimsey, *Topographic Terms in Virginia,* Reprints and Monographs, No. 3 (New York, 1940), Hamill Kenny, *West Virginia Place Names* (Piedmont, W. Va., 1945), and E. Wallace McMullen, Jr., *English Topographic Terms in Florida, 1563–1874* (Gainesville, Fla., 1953).

[6] The interesting but vexing problem of the relationships between vernacular "topographic" language (using the word in its extended sense) and the generic terms employed in place-names has apparently been left wholly unexplored. A large body of valuable material on vernacular usage is now available in the work of the group headed by Hans Kurath, *viz., Linguisitc Atlas of New England,* 6 vols. (Providence, 1939–43), subsequently referred to as *LANE*, and *A Word Geography of the Eastern United States* (Ann Arbor, 1949). The correlation of such material with the generic usages in place-names will provide a major research problem in the years to come.

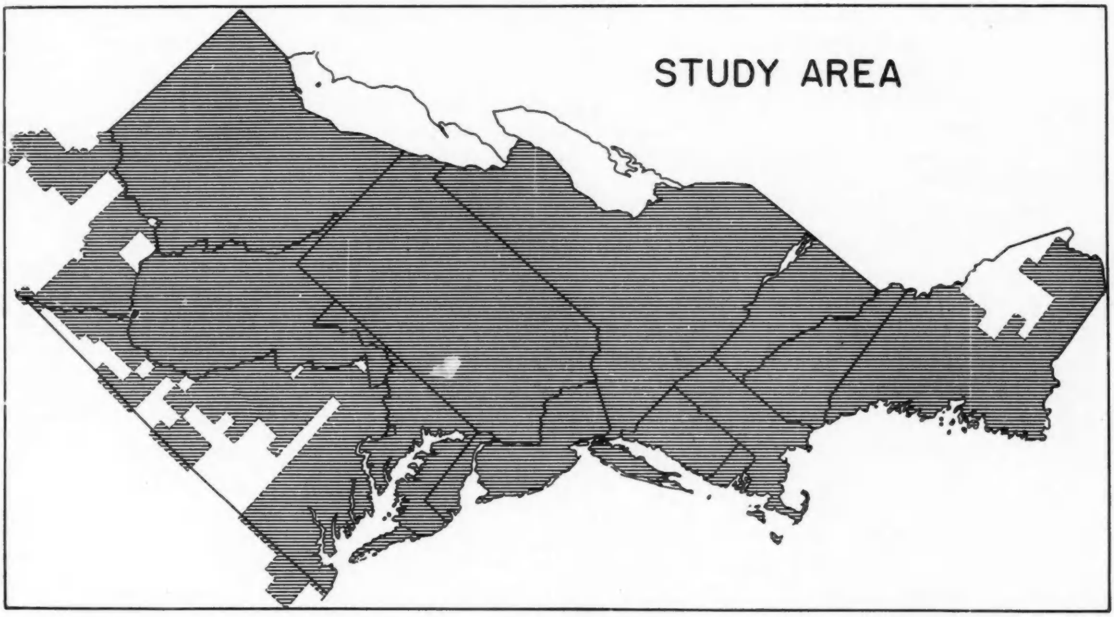

FIG. 1

for lack of adequate coverage, and of that large group applied to coastal features. Because of the enormous number of places named on highly detailed coastal charts and the peculiar cartographic problems involved in depicting their essentially linear distributions, it was deemed best to bypass these terms at present, but not without voicing the hope that they will soon receive the attention they merit. Two final limitations have been the elimination of most terms that occur with great rarity or as minority elements in restricted tracts and, on the other hand, those that are universal in the sense that they occur abundantly wherever their use is appropriate. No doubt many intrinsically important terms are left out by such a policy; but this decision was dictated by a concentration of interest in the major regional variations in the place-name cover.

It is readily demonstrated that the topographic sheets used for this study are in many respects gravely deficient as sources of place-names. The relative completeness and accuracy of the names on a given sheet will vary with its scale, date, and the particular area involved. Furthermore, since the collection of place-names was of incidental interest to government agencies concerned primarily with such matters as relief, hydrology, and material culture, the quality of the toponymic content may differ greatly from one surveyor or map editor to another. In more exacting studies these topographic sheets must be supplemented by a wide variety

of other maps, local literature and archival materials, and intensive field work, not only to fill in the details of the contemporary place-name pattern but also to trace the all-important changes that have occurred in the past. Notwithstanding these reservations, the maps accompanying this text afford a meaningful, if crude, approximation of the more or less contemporary distribution of some of the more regionally significant generic terms within the study area.

STREAM TERMS

Any observant map-reader who compares large-scale maps of the United States with those of Western Europe will be struck by the relative paucity of place-names on the former—even making generous allowance for omissions by map-makers.[7] This difference, which is difficult to define quantitatively, may be attributed to the recency of settlement and the simpler history of America, the lower average population densities (and, hence, the coarser grain of the cultural landscape), and, in many areas, the less complex character of physical features.

Among the various classes of physical features in the Northeastern United States, streams appear to be the most often named.[8] Since a generic term is invariably appended when these names are formally recorded on maps,[9] a large mass of stream terms await the attention of place-name geographers. Although a total of perhaps no more than a score of terms are in use for the many thousands of streams in the study area, some of them rather rare and special, it is important to note the existence of some significant sub-classes within this restricted group of words.

First, different terms may denote distinctions in the size of streams. Thus in the Deep South the terms *river*, *creek*, and *branch* (or *fork*, form a hierarchy expressing decreasing magnitude.[10] In Maryland the series is augmented by *run* as an intermediate category between *creek* and *branch*.[11] Farther northward, such series as *river-creek-run* or *river-brook* are prevalent, with the term *river* always unrivalled as a label for the largest streams.[12]

A major distinction must also be made between terms applied exclusively to

[7] John K. Wright, "The Study of Place Names; Recent Work and Some Possibilities," *Geographical Review*, Vol. XIX, No. 1 (1929), p. 141.

[8] A valuable discussion of the psychology of naming or not naming particular features is found in George R. Stewart, "What is Named?—Towns, Islands, Mountains, Rivers, Capes," *University of California Publications in English*, No. 14 (1943), pp. 223–32.

[9] Although sometimes omitted or suppressed in local vernacular usage. James B. McMillan, "Observations on American Place-Name Grammar," *American Speech*, Vol. XXIV, No. 4 (1949), pp. 241–48.

[10] Much overlap in usage may exist, but in the aggregate the size distinctions implicit in these terms are unmistakable.

[11] J. Louis Kuethe, "Runs, Creeks, and Branches in Maryland," *American Speech*, Vol. X, No. 4 (1935), pp. 256–59.

[12] Because of this universal usage, the term river has not been mapped in this study. A problem of some interest is the regional variation in the size of streams to which a given term (*river* among them) may be assigned.

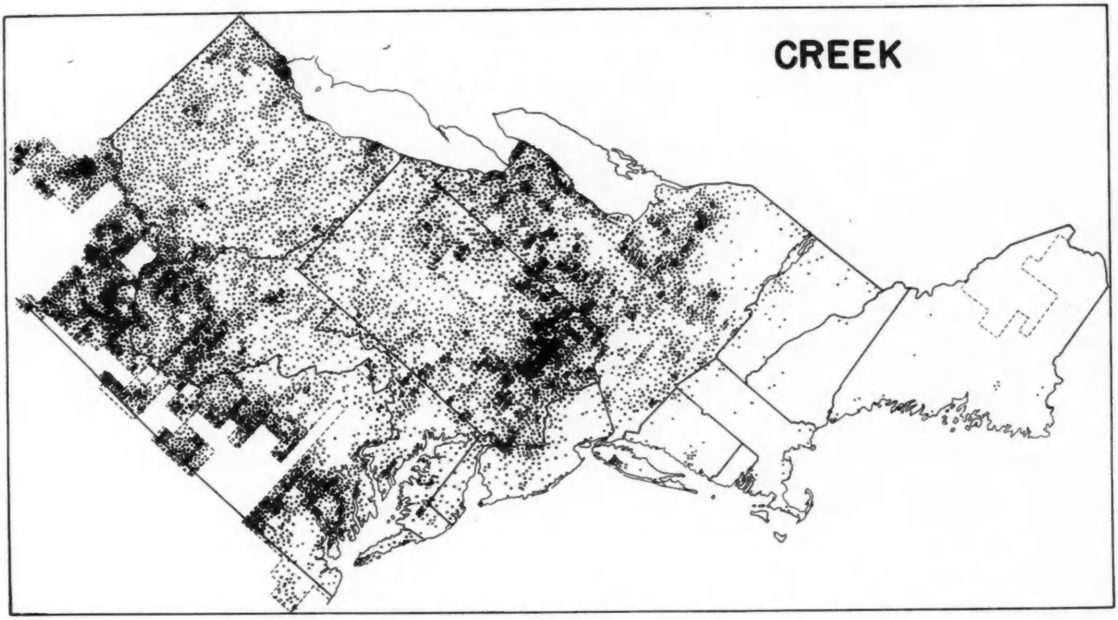

FIG. 2

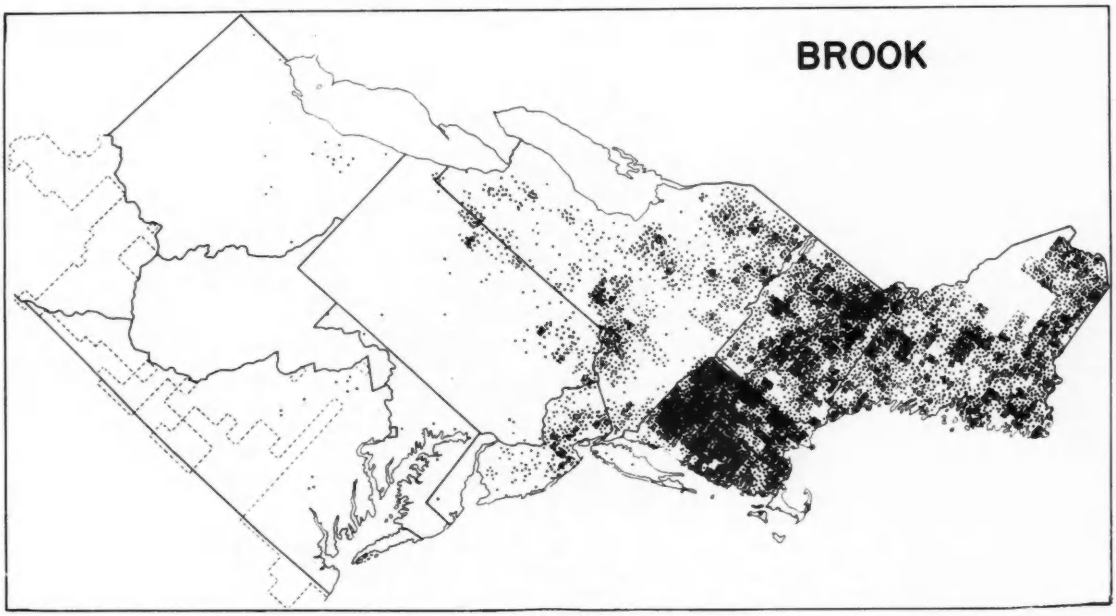

FIG. 3

tributaries and those that may be used for either tributaries or master streams. There are many cases where a tributary acquires a name wholly independently of the main stream (in which event the size hierarchy of terms comes into play); but such terms as *branch, fork,* or *prong* are frequently used to denote tributaries, often in conjunction with some directional adjective, such as "right" or "left," "north" or "south," or "upper" or "lower."[13] The matter is complicated, however, by the fact that in some regions *branch* and *fork,* through a process whose history is most obscure, have acquired the status of full generic terms, as in "Grassy Fork" rather than "West Fork" of So-and-So Creek. As will be seen, these variant usages depart sufficiently in areal distribution from the parent forms so that they may be accepted as distinct terms.

The choice of a generic term for a stream may also be affected by its velocity or some other physical characteristic. Thus, in his study of Maryland stream names, Kuethe discovered that *run* was applied to streams of high velocity (in the mountains and Piedmont), while *branch* was most frequently adopted for those of moderate current, and *creek* was used for the most sluggish (in the Coastal Plain).[14] In southeastern Virginia and in other parts of the South not covered by this survey, streams which flow slowly through swampy areas may receive the appellation *swamp*. In the glaciated country of New England and northern New York the terms *deadwater* and *flowage* are sometimes employed for streams that have been partially obstructed so that they have swollen nearly to the dimension of lakes. Elsewhere within this same region the terms *inlet* and *outlet* are used aptly enough for streams entering or leaving glacial lakes. Where streams pass by "a spot to which animals resort to lick the salt or salt earth found there,"[15] the word *lick* is often used as part of a compound specific name, e.g., "Elk Lick Branch," and sometimes, but less frequently, as a pure generic term, e.g., "Elk Lick." In those parts of Tidewater Virginia and the Eastern Shore where ditches have been dug intermittently to drain low ground, it is sometimes impossible to distinguish artificial from natural channels, and the term *ditch* may occasionally be used for the latter.[16]

Since large streams are almost invariably designated as *rivers* in the Northeastern United States, our attention here is limited to the distribution of terms for medium- and small-sized streams. Of these, probably the most important is *creek* (Fig. 2),[17] for it occurs in considerable numbers almost everywhere west and south of the Adirondacks and Hudson River in association with medium-sized streams.[18] Like many other important generic place-terms, *creek* is an Americanism in the

[13] But seldom, if ever, are ordinal numbers employed, as in the Far West. George R. Stewart, "Nomenclature of Stream-Forks on the West Slope of the Sierra Nevada," *American Speech,* Vol. XIV, No. 3 (1939), pp. 191–97.

[14] Kuethe, *op. cit.,* pp. 258–59.

[15] James A. H. Murray, ed., *A New English Dictionary on Historical Principles,* 10 vols. (Oxford, 1883–1928). Hereinafter referred to as *NED.*

[16] McJimsey, *op. cit.*

[17] In this map, as in subsequent ones, each dot corresponds to a single occurrence of the usage.

[18] Not only within the study area but throughout most of Anglo-America.

sense that the British word has acquired an entirely novel connotation on this side of the Atlantic. There are hundreds of instances along the American coast of *creek* being used in its original sense of salt-water estuary or embayment, but its application to fresh-water inland streams is a North American innovation. Students of the American language have not yet fully accounted for this shift in meaning, but the *NED*'s surmise is the most probable and widely accepted explanation:

> Probably the name was originally given by the explorers of a river to the various inlets and arms observed to run out of it, and of which only the mouths were seen in passing; when at a later period these 'creeks' were explored, they were often found to be tributaries of great length, and 'creek' thus received an application entirely unknown in Great Britain.

Such a hypothesis is strengthened by the near absence of the term in interior New England (as noted in *LANE*). The gradual merging of brackish estuaries with inland streams that occurs within the broader coastal plains to the south is a rarity along the rugged New England coast, and so too the opportunity for extending the term inland. Not much significance need be read into the variations in the frequency of *creek* outside New England, for most of these are caused by shortcomings in map sources or by variable numbers of nameable streams. The decreased importance of the term in the central portion of the study area is largely the effect of strong competition from *run,* which is used for medium-sized as well as small streams.

The distribution of the important stream term *brook* (Fig. 3)[19] is in most respects the converse of that of *creek,* for it is well represented in New England, New York, New Jersey, and northern Pennsylvania but is relatively uncommon elsewhere.[20] Within the area of its principal concentration, *brook* is used in the common English sense of a small stream or rivulet—in southern New England almost to the exclusion of other terms.[21] The distributional pattern is closely coincident with that of the New England culture area and with its westward expansion during the late 18th and early 19th centuries. Since the original sense of *brook* is "a torrent, a strong flowing stream" (*NED*), the term was much less applicable in the coastal territories south of New York Harbor and, although in occasional use there, had a slimmer chance of being adopted and spread inland than in hilly New England.

Southwestward of the region dominated by *brook,* the great majority of small streams are termed *runs* (Fig. 4).[22] The substitution of this usage for the equally appropriate *brook* throughout most of the central portion of the study area is difficult to explain. In Great Britain, the term is confined to northern England and portions of Scotland, specifically Yorkshire, north Lincolnshire, Norfolk, and Lanark, where it is regarded as dialectal.[23] Further research into the British his-

[19] Kurath, *Word Geography of Eastern U. S.,* Fig. 93.

[20] Although occurrences as far south as Florida can be found. McMullen, *op. cit.*

[21] The unusually heavy concentration of *brooks* in southern New England in Figure 3 is probably as much the result of superior map coverage for that area as of any pronounced areal differential.

[22] Kurath, *Word Geography of Eastern U. S.,* Figs. 18 and 93.

[23] *NED;* and Joseph Wright, ed., *The English Dialect Dictionary* (Oxford, 1898–1905).

tory of *run* is necessary before its American distributional pattern can be accounted for; but two hypotheses suggest themselves: (1) *Run* may have been a waning but still widespread term in Great Britain at the time of its introduction into America where, for unknown reasons, it failed to gain much of a foothold except within its present range,[24] or (2) the term was taken to Pennsylvania and Maryland by the Scotch-Irish immigrants who were familiar with it in their homeland and thence carried westward by the advancing frontiersmen.[25] At any rate, it is tempting to correlate the area dominated by *run* with the Midland speech demarcated by Kurath in his *Word Geography of the Eastern United States* and to seek a common origin for both. It is especially interesting to note the unusually sharp boundary dividing *run* from its equivalent term *branch* in Virginia and West Virginia.

The use of *branch* in the English sense of a tributary and in conjunction with a directional specific is so widespread within the study area that its occurrence was not plotted. The second major usage of *branch*, as a full-fledged generic term, is an Americanism with a curiously spotty distribution (Fig. 5).[26] Although there is a decided preponderance of *branches* in the nomenclature of small streams in most of the southern part of the study area[27]—and particularly in the Appalachians—there are sizeable clusters of occurrences in southern New Jersey, parts of Vermont and New Hampshire, and that north-central Pennsylvania region which will presently be seen to be anomalous in other respects. Within its more southerly range, the important concentration in Maryland and the Eastern Shore is striking.

It is noteworthy that even in the zone of greatest frequency, *branch* (in its full generic sense) does not dominate nearly so much as *brook* or *run* do in their respective areas, for it faces severe competition from both *fork* and *creek*. A fragmented distributional pattern and the complex series of physical connotations may well indicate a complicated history. It is obvious that *branch* in its full generic sense stems directly from the original tributary term, but the locus and method of the transition are uncertain, as is the question of whether a single or multiple origin can be ascribed to it. Neither are there sufficient data on hand to settle the major problem of the dominance of *branch* in the Southeastern United States.

In spite of lower frequency and greater restriction of range, the term *fork* presents an interesting parallel to *branch* (Fig. 6). Again a word with a purely tributary sense in Great Britain has retained its original usage rather generally but

[24] In this connection the few New England occurrences and those in the Mohawk Valley (Cf. Edward Everett Hale, Jr., "Dialectical Evidence in the Place-Names of Eastern New York," *American Speech*, Vol. V, No. 2 (1929), pp. 154–67, may be of considerable significance.

[25] The fact that Kurath (in *Word Geography of Eastern U. S.*) notes isolated occurrences of *run* in those portions of eastern North Carolina settled by Scottish immigrants would seem to support such a hypothesis.

[26] Also see Kurath, *Word Geography of Eastern U. S.*, Fig. 93.

[27] And throughout the remainder of the Southeastern United States. *Webster's New International Dictionary of the English Language*, 2nd ed., unabridged, hereinafter referred to as *Webster*, and Maximilian Schele de Vere, *Americanisms; the English of the New World* (New York, 1872).

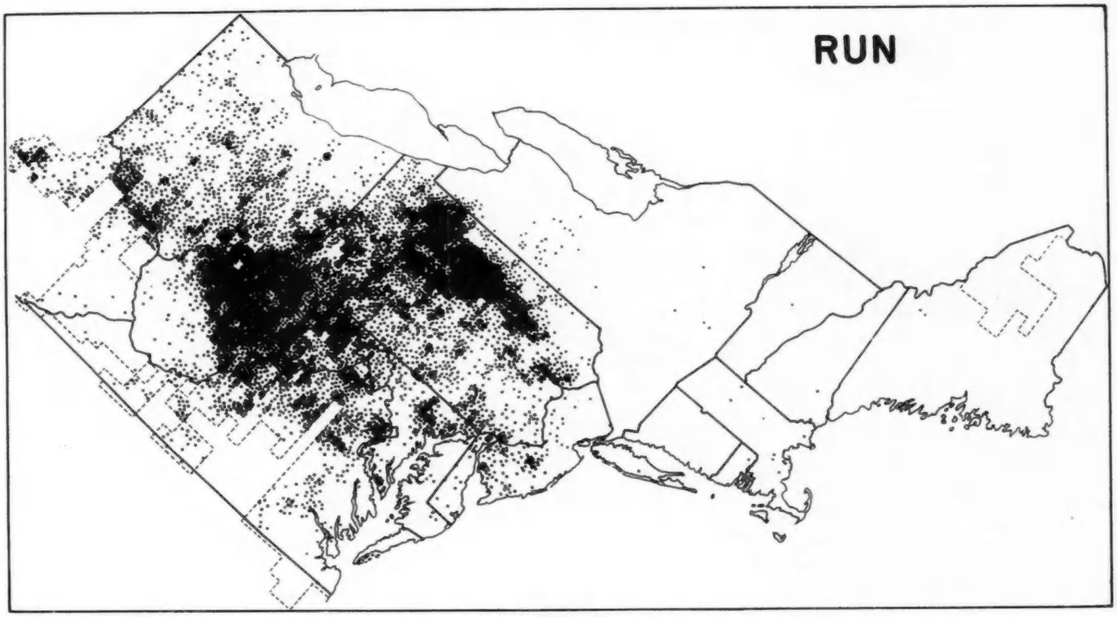

FIG. 4

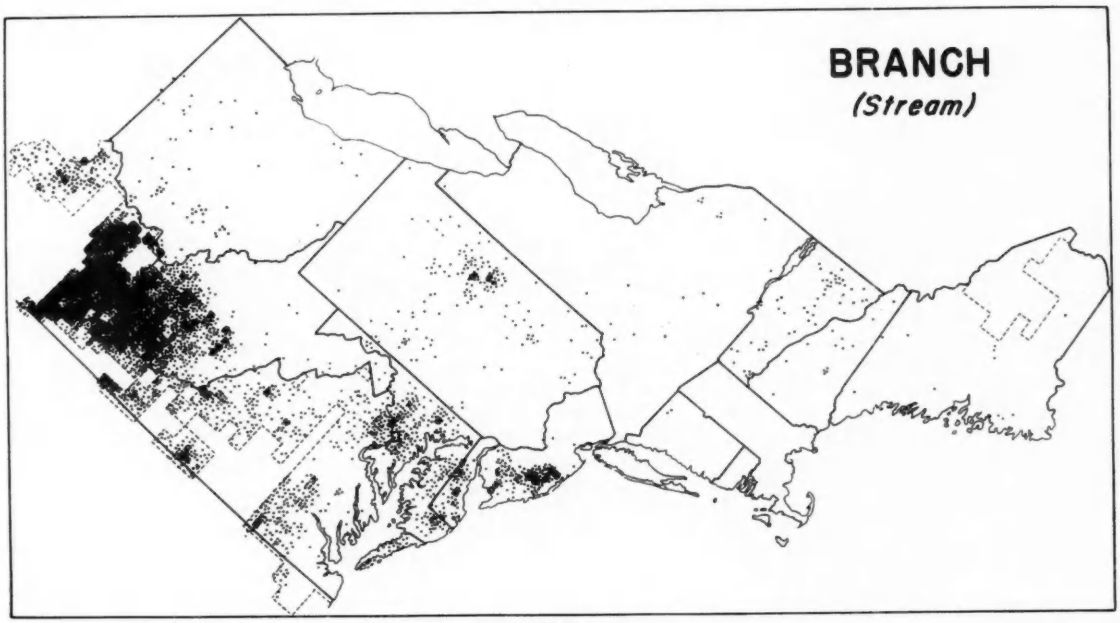

FIG. 5

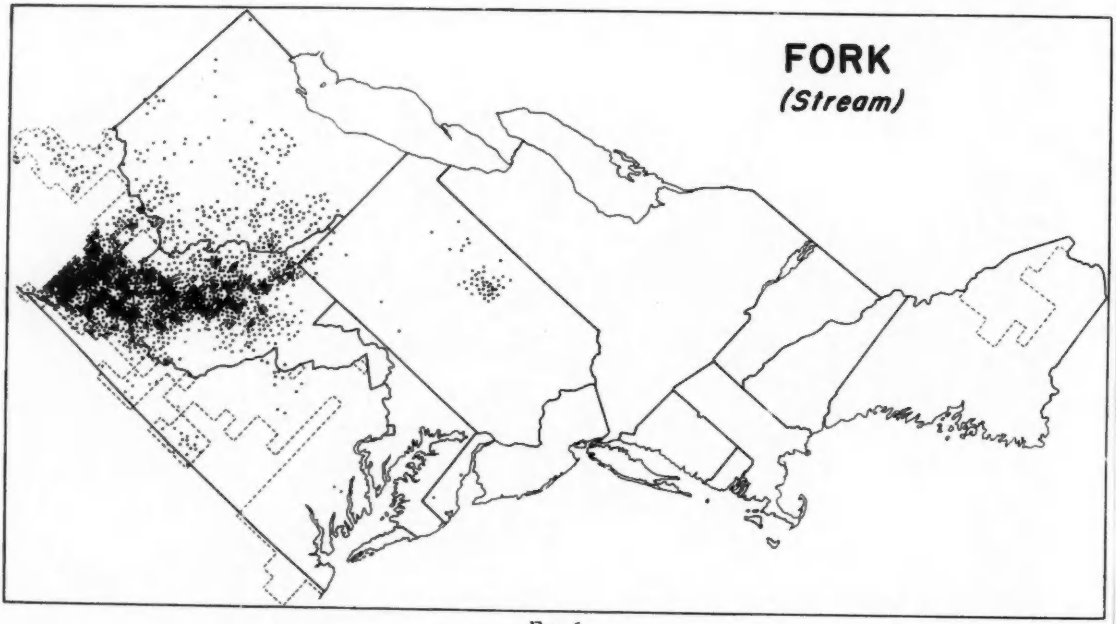

FIG. 6

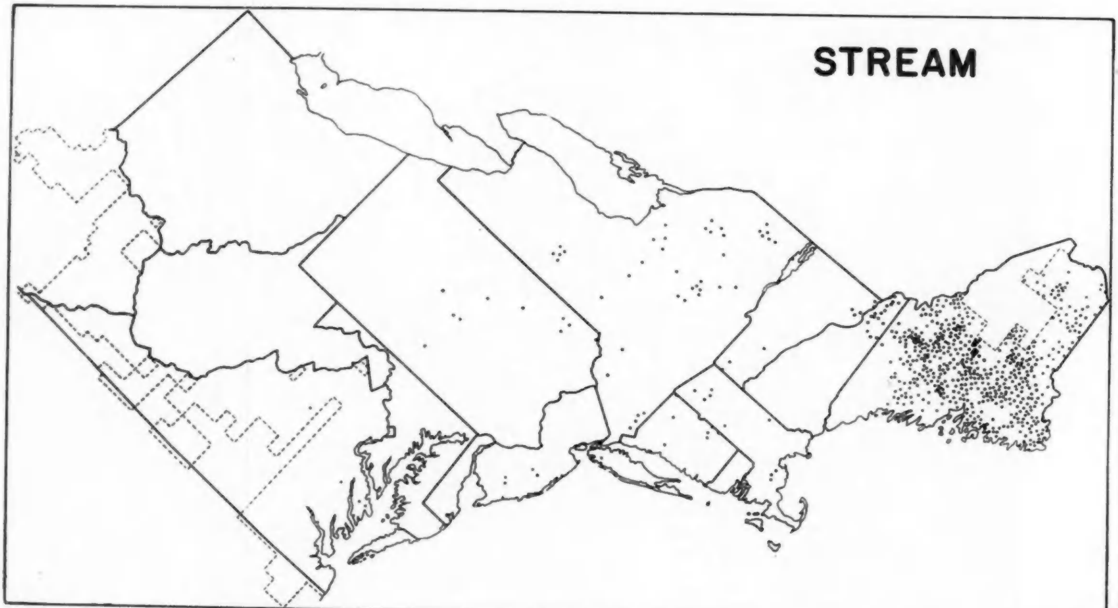

FIG. 7

has been transformed locally into a full generic term. In this case, however, the Americanism is apparently wholly absent from the northeastern half of the study area—except for the aberrant north-central Pennsylvania tract—and is almost completely an inland, montane phenomenon. The absence of *fork* in the oldest colonial regions suggests the possibility of a relatively late origin along an inland frontier.[28]

The closely similar term *prong* is much less current than either *branch* or *fork*. In its basic sense of a tributary, only twenty-six occurrences are noted on maps of the study area—all within its southern half.[29] Thirteen cases of the use of *prong* in the full generic sense of stream have been recorded—eight in Delaware and five in Virginia. The lateness of the earliest *DAE* and McJimsey citations (1725 and 1770 respectively) would make this appear to be another relatively recent term.

In Maine and northern New Hampshire the term *stream* is applied to many and sometimes a majority of medium-sized watercourses; but its use is greatly restricted in other parts of New England and in New York, New Jersey, Pennsylvania, and Virginia, and it is unknown elsewhere in the study area (Fig. 7). This distributional pattern is not only unexplained but scarcely noticed in American place-name literature.[30] There is nothing unusual in the physical context of *stream* to help solve the question;[31] but recency of the first recorded occurrence in Virginia (McJimsey, 1820) may be an important clue, for the northern New England tract in which *stream* achieves its greatest prominence is one of recent settlement.

In contrast to *stream*, the limitation of the term *kill* to the Hudson Valley, Catskills, and upper Delaware Valley (Fig. 8) can be accounted for quite readily. This Dutch equivalent of *brook* or *run* is almost exactly coterminous with the region of significant, or even transient, Dutch settlement. It is interesting to note occurrences as far afield as the Mohawk Valley, Delaware, and Berks County, Pennsylvania. The relative scarcity of *kills* along the lower Hudson Valley and on Long Island is not so easily explained, although detailed historical investigation might show that Dutch toponymy was more thoroughly supplanted by English terms here than in less accessible areas.

The term *lick* has already been cited as one used not only in its strict original sense but also quite often within the specific name of a stream (Fig. 9) so as to take on some generic attributes. Until a study has been made of the geography of salt licks and their place in the frontier economy, it will be difficult to determine how closely *lick* as an element in stream nomenclature coincides with the physical and economic entity. What does appear certain from the map is that *lick* is a Southernism, prob-

28 A hypothesis bolstered by the rather late date for the earliest occurrences yet recorded, *viz.*, 1697, in Sir William A. Craigie and James R. Hulbert, *A Dictionary of American English on Historical Principles* (Chicago, 1938–44), hereinafter referred to as *DAE*, and 1721 (McJimsey).

29 Thus supporting the *NED*'S contention that *prong* is a Southernism.

30 Hale, *op. cit.*, p. 165, mentions the occurrence of *stream* in the Adirondacks without comment.

31 *Webster* equates the term with *brook*.

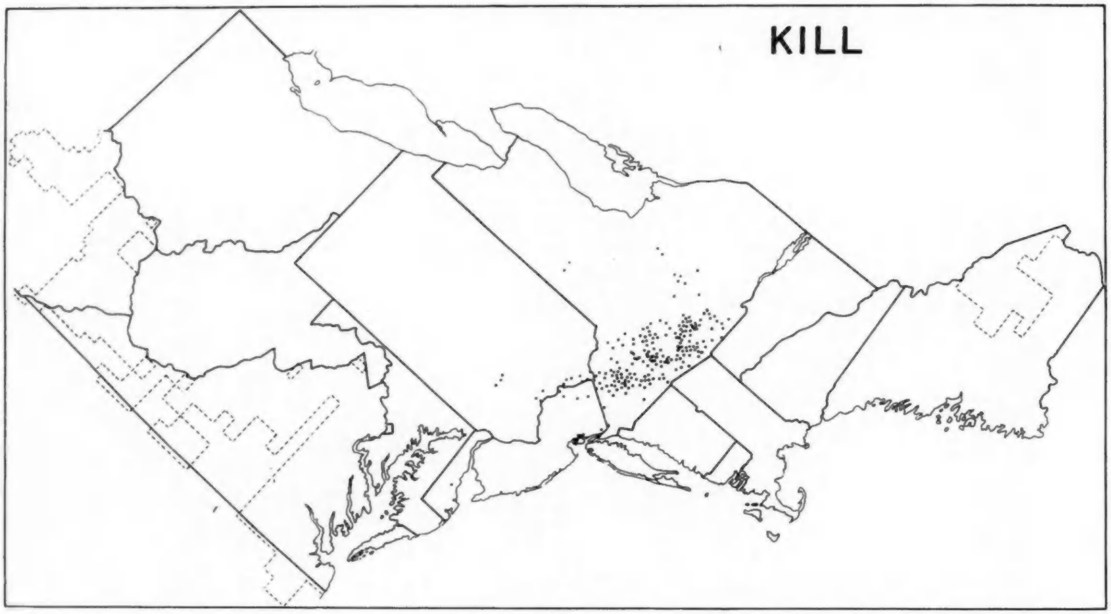

FIG. 8

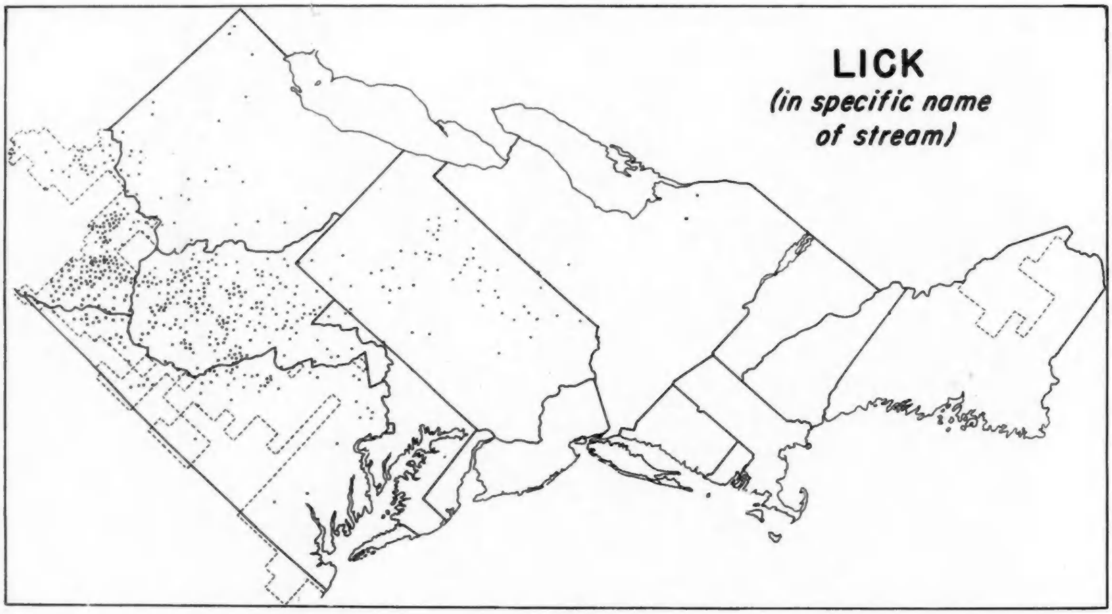

FIG. 9

ably of late origin along the frontier.[32] The use of *lick* as a full generic term for stream occurs in scattered localities in West Virginia and in the adjoining portions of Virginia, Kentucky, Ohio, and western Maryland—as well as in north-central Pennsylvania.

Among the remaining minor terms used for drainage features, one of the more interesting is *ditch*. The ambiguity of its connotations on the Eastern Shore has been mentioned previously, but the same phenomenon occurs in poorly drained sections of northern and northwestern Ohio (and other Middle Western areas). A parallel term—*drain*—is found infrequently within the study area but abounds in the formerly swampy tracts of southeastern Michigan.

LAKE TERMS

The percentage of lakes endowed with names within the Northeastern United States is almost as high as that of streams, even though only two generic terms—*lake* and *pond*—are in common use.[33] *Lake,* a widely current English term, is applied in the British Isles to larger bodies of water, but in America to specimens of almost any size. The term may precede or follow the specific in a name but is most often found in a terminal position.[34] *Pond* is, in a sense, an Americanism, for its common meaning in England is "a small body of still water of artificial formation" (*NED*) and only locally is it equivalent to a small lake. In studying the highly divergent patterns of *pond* and *lake* in Figures 10A and 10B, it must be remembered that lakes are an important phenomenon only in the glaciated northern section of the study area. Within this region, *pond* predominates greatly throughout all New England, except northeastern Maine, and in eastern New York. Although *lake* is generally reserved in New England for larger bodies of water, there is an extremely wide overlap in usage, many a *pond* being larger than a *lake*. The manner in which this special, local English term came to dominate in New England (and the more lacustrine portions of the Chesapeake Bay region) at an early date[35] remains a mystery. *Lake* is used most frequently in northeastern Maine, the western Adirondacks, northeastern Pennsylvania, and northern New Jersey—the outer rim of the lake zone of the Northeastern United States.[36]

[32] A recent origin is suggested by the dates of the earliest citations: 1747 in McJimsey, 1747 in Mitford M. Mathews, ed., *A Dictionary of Americanisms on Historical Principles* (Chicago, 1951), and 1750 in *DAE*.

[33] *Tarn, pool, mere, loch,* and *zee* occur, but with great rarity.

[34] McMillan, *op. cit.,* p. 247.

[35] The *DAE* records the use of *pond* in 1622; Clarice E. Tyler, "Topographical Terms in the Seventeenth Century Records of Connecticut and Rhode Island," *New England Quarterly,* Vol. II, No. 3 (1929), pp. 382–401, in 1644.

[36] Figure 10B records only those cases where *lake* is used in a terminal position; but the areal pattern for antecedent cases is much the same. The term *mill pond,* used apparently in the original English sense, is scattered throughout the older portion of the study area, with the largest number of occurrences in the Chesapeake Bay region.

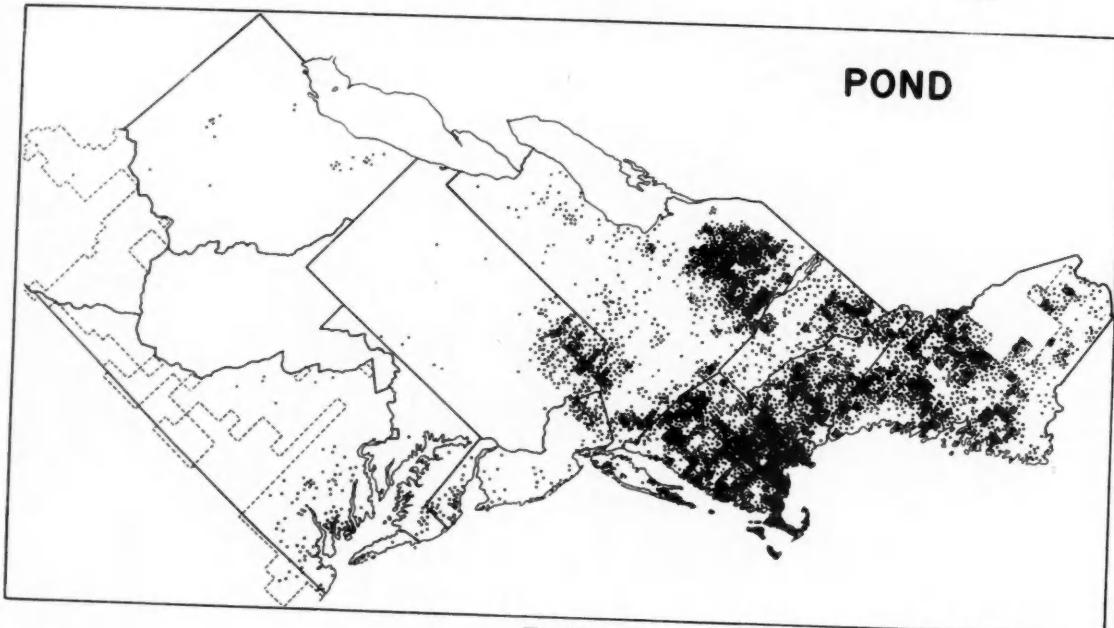

FIG. 10A

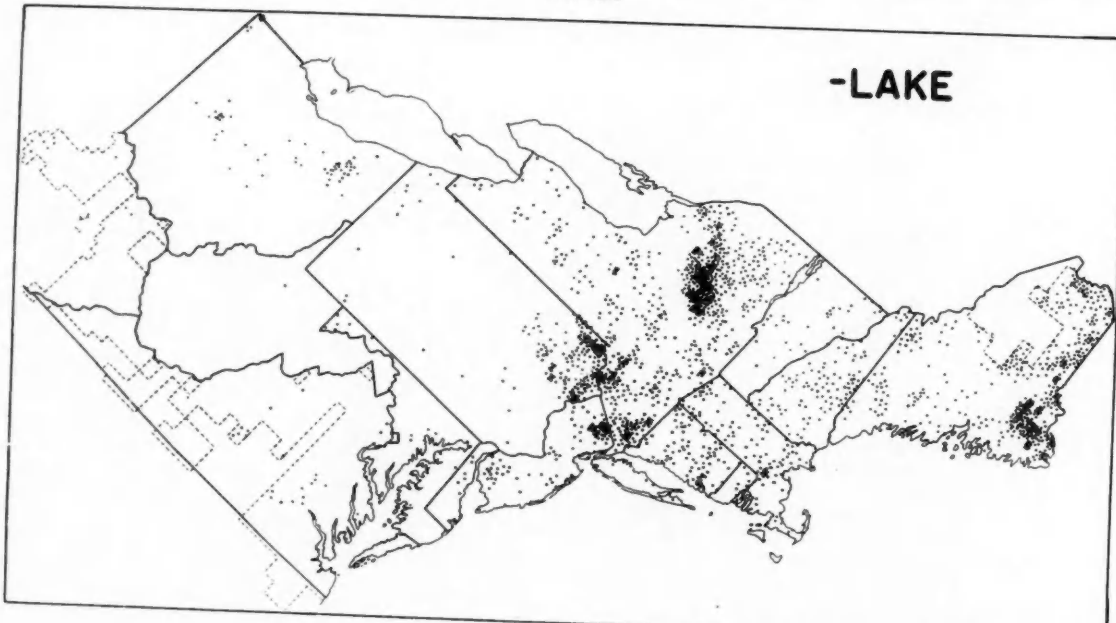

FIG. 10B

UPLAND FEATURES

The extent to which hills, mountains, and other eminences have been named in various regions of Anglo-America presents interesting irregularities. The majority of eligible places in New England possess names, as do most of those throughout the Folded Appalachians; but in that hilliest of areas, the Appalachian (i.e., Allegheny and Cumberland) Plateau, only a small minority of highland tracts are dignified with names.[37] Among the array of generic terms used for upland features, several are so widespread as to lack regional significance. The most notable example is the ubiquitous *mountain;* but *top* (along with its derivative *roundtop*), *peak, mound,* and *rock* are also important. The widely prevalent *ridge* offers the interesting problem of a single term covering a multiplicity of features from an insignificant line of sand dunes or a river levee to a huge mountain rampart.

The term *hill* is favored throughout the United States for protuberances of less than mountain size; but in New England—and particularly the southern half of the region—*hill* is employed for a wide variety of landforms of great range in magnitude, far outstripping all competitive terms (Fig. 11A). In the Southern Appalachians *hill* yields precedence to *knob* (Fig. 11B), an Americanism that appears to be of late origin.[38] The term *mount,* used in Great Britain for "a more or less conical hill of moderate height rising from a plain" (*NED*), occurs widely throughout the United States, with an especially large concentration in New England and eastern New York. *Mount* is perhaps unique in that the word is obsolete in the vernacular except for its survival in place-names (*DAE*). The influence of biblical nomenclature on the popularity of the term in New England would bear investigation.

Perhaps the most curious term used as a synonym for *hill* within the study area is *cobble,* which is defined by the *DAE* as "a round hill . . . name applied to a hill or other moderate elevation whose sides have a covering of loose or cobble stones." The generic term is evidently unknown in the British Isles, and a German or Austrian derivation is suggested by the *DAE* and Whitney.[39] The fact that the 30 or 40 occurrences discovered in this survey are limited to eastern New York and western New England might suggest diffusion from a Dutch source in the Hudson Valley.[40]

Unlike some mountainous regions of Europe, there is a distinct scarcity of names for the component sections of individual hills and mountains in the United States. In the northern half of the study area a "shelf-like projection on the side of a rock or mountain" (*NED*), or sometimes the whole eminence, may be termed

[37] Possibly because of the generally uniform size and appearance of hills.

[38] The *NED* cites *knob* thus; the earliest uses recorded by McJimsey and *DAE* are 1777 and 1796, respectively. J. D. Whitney, *Names and Places; Studies in Geographical and Topographical Nomenclature* (Cambridge, England, 1888) states (pp. 106–07): "There is an occasional 'knob' in the Eastern United States, both in the White Mountains and in the Catskills; but the topographical use of this word is decidedly a Southwestern [i.e., South-Central United States] peculiarity."

[39] Whitney, *op. cit.,* pp. 109–11.

[40] Within the same general area there are numerous cases where *cobble* is used as a quasi-generic term in the specific portion of a place-name.

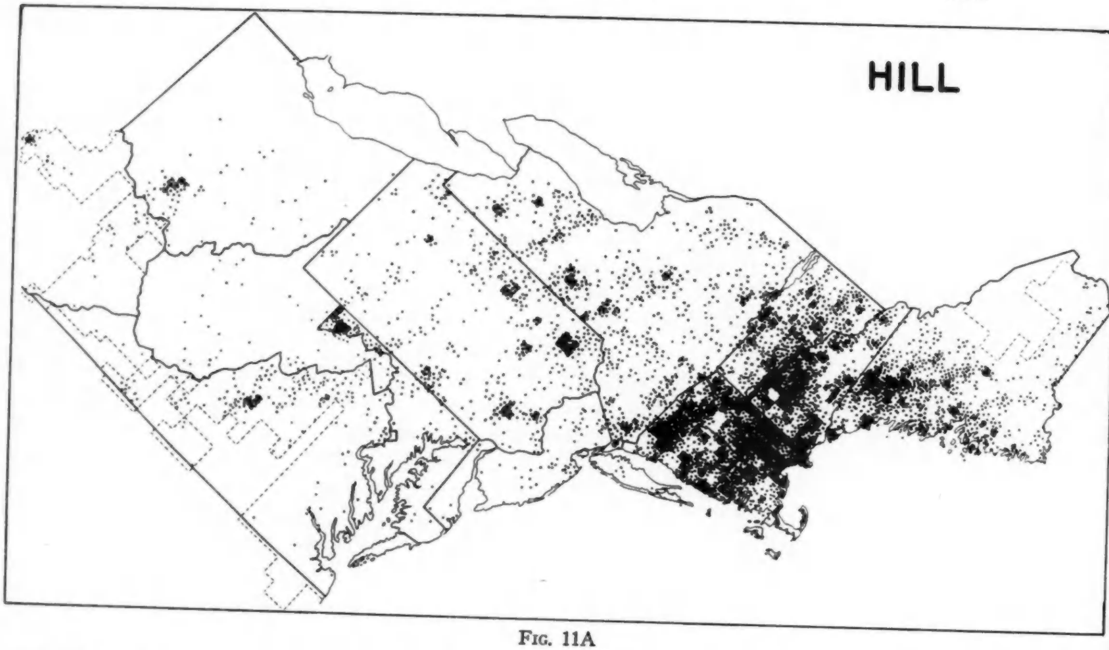

FIG. 11A

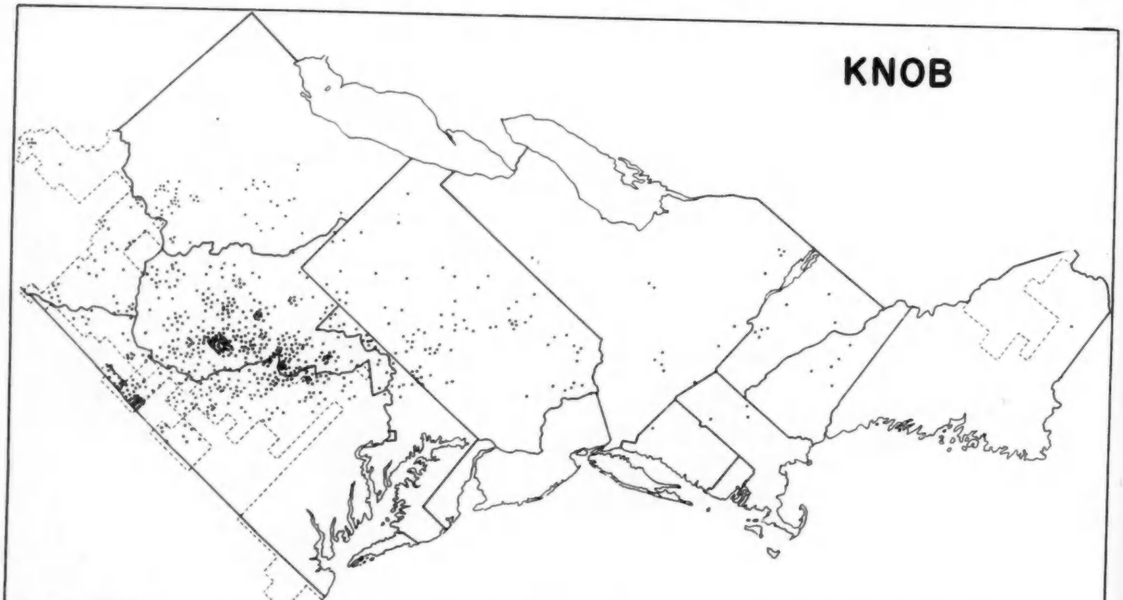

FIG. 11B

a *ledge* (Fig. 12), a thoroughly English usage, while in the Southern Appalachians the Americanism *spur* is applied to the rib-like flanks of some mountains.[41] Passes across ridges and mountains are only occasionally bestowed with names, and then in those areas where they are of particular importance in the local routing of communications. The term *pass* occurs in all appropriate sections of the study area, but less often than might be expected.[42] Within New England the Americanism *notch* is greatly favored,[43] especially in the White Mountains, but the term also appears in New York and Pennsylvania (Fig. 13). A rather late origin is indicated for *notch*[44] in contrast to the antiquity of almost all other New England terms. Within the Appalachians southward from central Pennsylvania—and to a lesser extent in the Poconos, Catskills, and northern Vermont—passes are denoted as *gaps* (Fig. 14). This term does occur infrequently in Great Britain but did not achieve widespread popularity in the United States before the mid-eighteenth century.[45]

[41] A late origin is likely since the earliest examples in McJimsey and the *DAE* both date from 1737.

[42] The only locality in which it appears to outnumber alternative terms is the Adirondacks, according to Hale, *op. cit.*, p. 164.

[43] Whitney, *op. cit.*, p. 135.

[44] The earliest citation in the *DAE* is 1718, in McJimsey, 1832.

[45] McJimsey's earliest citation is dated 1741; that of the *DAE*, 1750.

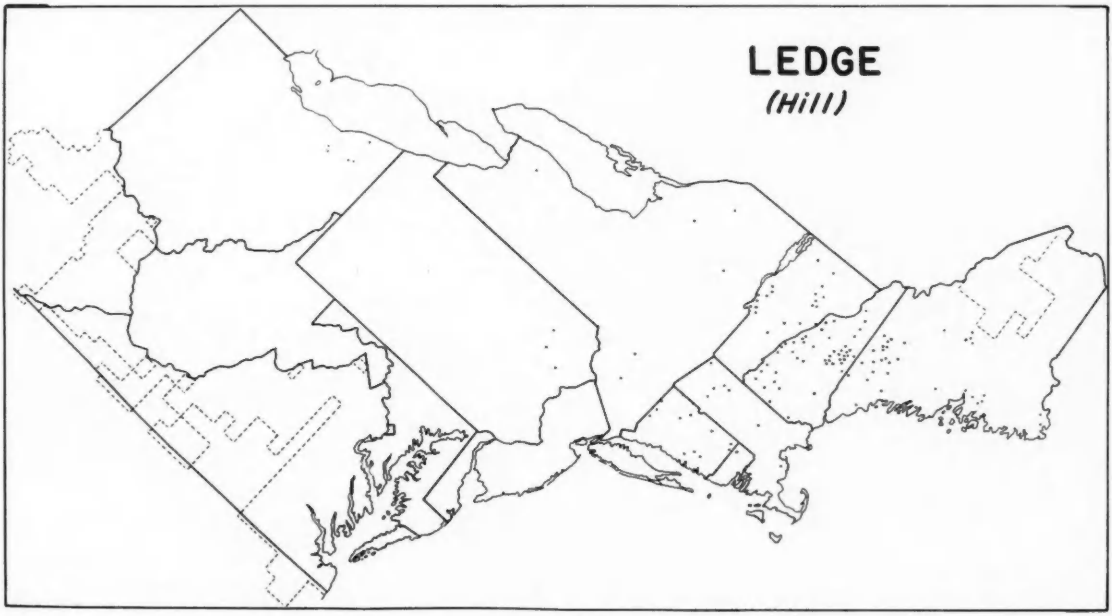

FIG. 12

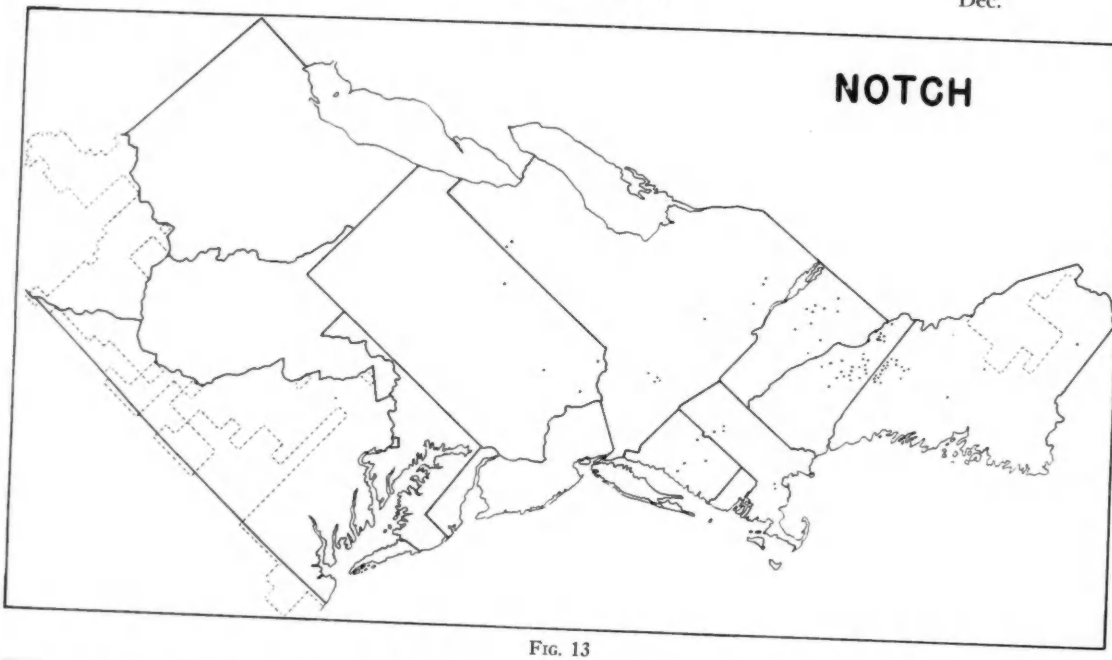

FIG. 13

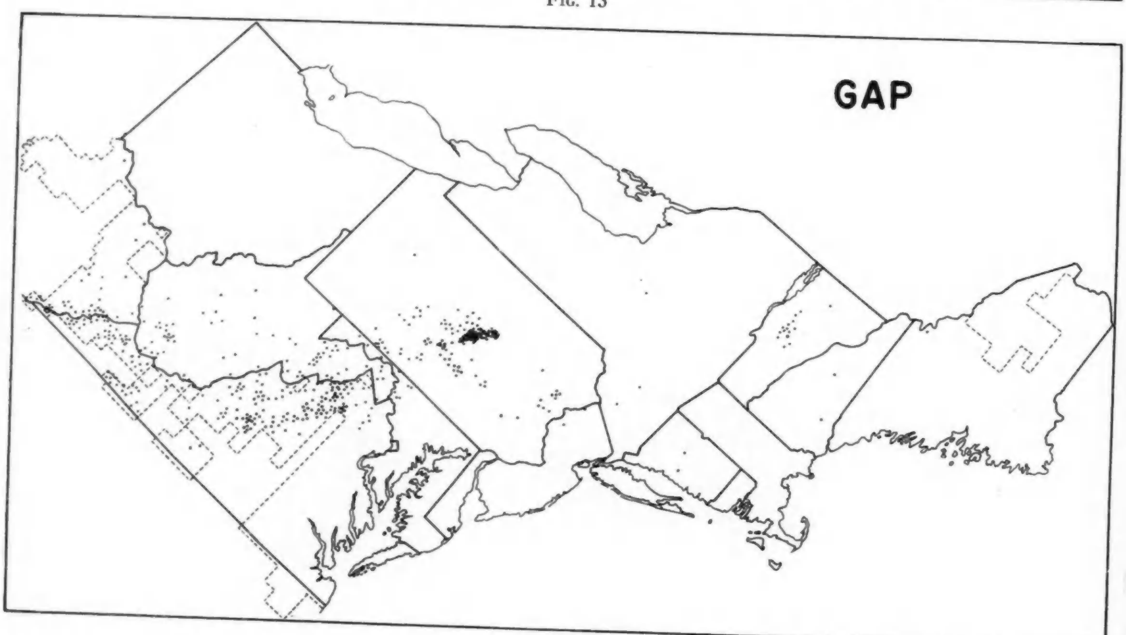

FIG. 14

LOWLAND FEATURES

Lowland tracts, basins, valleys, and the like have gone nameless in a great majority of the places where they lack strong physical individuality. Since it is difficult to decide which lowland areas merit proper names—outside such obvious candidates as the Appalachian valleys—it is likewise difficult to determine which generic terms are regionalized and which relatively universalized in distribution. An additional complication is created by the widespread habit of regarding stream names as adequate labels for lowland areas, which often are not otherwise designated.[46] Thus it is uncertain whether the three most popular terms—*valley, hollow,* and *bottom*—display any genuine regional concentration. All are abundant in the rougher areas south and west of New England and poorly represented in the latter region. Clearly, a more refined definition of these terms and their relationship to river and pass terms is called for.

Other lesser terms do, however, cluster within more limited ranges. Thus *gorge, gulf,*[47] *glen,*[48] and *gully*[49] are restricted to the northern section of the study area, especially western New York;[50] and *clove,* from the Dutch *klove* or *kloof,* is used for "a rocky cleft or fissure; a gap, ravine" (*NED*) in and near the Catskills. Within the Southern Appalachians the term *cove* is current for a rather uncommon landform, "a recess with precipitous sides in the steep flank of a mountain."[51] A curious distributional puzzle is posed by the term *draft* which has been adopted for mountain ravines (and also watercourses) in two widely separated tracts: north-central Pennsylvania and an area in the Folded Appalachians along the Virginia-West Virginia boundary between parallels 37° 30′ and 38° 30′—and almost never elsewhere.[52]

VEGETATIONAL FEATURES

One of the more striking peculiarities of American toponymy is the near-absence of generic terms for vegetational features.[53] Such terms in the Northeastern United States as do have any floristic connotations refer primarily to drainage characteristics. Thus, the term *swamp* indicates, in general, "a tract of rich soil having a growth of trees or other vegetation, but too moist for cultivation" (*NED*).

[46] Indeed, it is sometimes impossible to judge whether a given term refers to the valley or the stream, e.g., *draft,* for which the *DAE* cites both meanings.

[47] "Deep and wide, between mountains," *LANE.*

[48] "Small and thickly wooded," *LANE;* originally a Gaelic term, *NED.*

[49] Usually used for valleys containing intermittent streams, *LANE;* possibly an Americanism.

[50] Whitney, *op. cit.,* pp. 157–58.

[51] *NED.* The same source also attributes the sense of "gap" or "pass" to *cove* in the United States but is probably incorrect in doing so. The term appears to have originated in the English Lake District, *DAE* and Whitney, *op. cit.,* p. 163.

[52] Although the term, alternatively spelled *draught,* is not so noted by the *NED,* the fact that the earliest citation dates from 1801 suggests the likelihood that it is an Americanism.

[53] J. K. Wright, *op. cit.,* pp. 143–44. The only important exception is provided by national and state forests. There are, however, innumerable allusions to plant life in the specific elements of American place-names.

Although the term has gained almost universal acceptance throughout North America, its greatest concentration appears along and near the Atlantic Seaboard. The etymology and areal source of the word are both obscure. Although it may possibly have been in local use in England around 1600 (*NED*), no documentary proof for this claim has been forthcoming, and the oldest citations yet discovered are in the early colonial records of Virginia.[54]

The widely used English term *meadow* was transferred to the American colonies at an early date but with some change in emphasis, for its American sense is defined as "a low level tract of uncultivated grass land, especially along a river or in marshy regions near the sea" (NED), and the LANE states that the "exact meaning varies considerably with the character of the country." At any rate, *meadow*—usually denoting a grassy, often poorly drained tract devoid of trees—failed to penetrate far into the interior of the study area, and today it is found mainly along the Atlantic Seaboard northward of Cape May, New Jersey.

The term *marsh,* like *swamp,* is widely prevalent in the United States, but almost always as a designation for an unforested, water-logged tract, either fresh or salt. Within the study area its primary concentration is in the Chesapeake Bay region. Once again within the Hudson Valley a Dutch term *vly* (or *vlie*) is applied to swamps and marshes. Notable by its absence in the study area is *slough,* a term of wide currency in the Middle West. In southeastern Virginia and thence southwestward along the coastal plain, the Algonquin term *pocosin*[55] is applied to poorly drained interfluves. Within New England and portions of New Jersey and New York fresh or brackish tracts "grown with tufts of grass (hummocks), cranberries, or blueberries, or without any growth" (*LANE*) and too small to be called *swamps* or *marshes* are designated as *bogs,* a usage not too far from the English.

It is interesting to note a few instances of the use of the venerable English term *fen* in Maine and Rhode Island. A rather more perplexing problem is posed by the use of the term *heath* within northeastern Maine (but evidently not in neighboring New Brunswick). The *NED* attributes no particular floral significance to the term, which in Great Britain apparently denotes a flat, rather bleak upland tract with or without heather or some other shrubby growth. In New England *heath* seems to be applied solely to level interfluves covered by cranberries, blueberries, or heather (*LANE*), but field work is needed to establish the precise physical connotations of the word. There is no explanation at hand for its presence in Maine and absence in other American regions.

AGGLOMERATED SETTLEMENTS

If considerable uncertainty surrounds the historical geography of many generic terms describing the relatively immutable physical features of the Northeastern

[54] *NED*. According to Robert Krapp (as quoted by Martha Jane Gibson in "'Swamp' in Early American Usage," *American Speech,* Vol. X, No. 4 [1935], pp. 303–05), the term was not used in Great Britain because all "swampy" tracts had long since been reclaimed and put under cultivation.

[55] Among the several spellings, the chief variants are *poquosin* and *pocoson*.

United States, then there is even greater scope for confusion in the study of most terms applied to the cultural landscape. The difficulties are particularly impressive in the study of the class of objects with the most diversified nomenclature—agglomerated settlements: There are great variations in the areal density of towns (Fig. 15); the names of individual places often have undergone one or more changes; and, in many cases, the generic element in the name is implicit rather than stated, as in, say, "Brewster," instead of "Brewster Village" or "Brewster City." Thus, a fairly exacting study of the distributional significance of various settlement terms would require the drafting of a time series of maps showing the number and location of all instances of a given usage as against the total number of settlements containing explicit generic terms in their names; and some account would have to be taken of settlement size and morphology—altogether a task of heroic dimensions. Because of this fact, the following statements are merely reasonable guesses.

Certain terms for agglomerated settlements can be safely characterized as universal, *viz., junction, crossing, landing,* and *forge* or *furnace,* as they occur in a large percentage of suitable situations. The suffix *-ton* probably falls into the same category, since there is scarcely a corner of the study area lacking this usage.[56] Another suffix, *-boro* or *-borough,* is much less common but seems to be as widely distributed. The status of *-ville,* perhaps the most popular term for a settlement in the Northeastern United States, is more doubtful (Fig. 16). There is a high degree of correlation between the pattern for *-ville* and that for the totality of agglomerated settlements (Fig. 15), but the unusually heavy concentration in south-

[56] In plotting *-ton* on manuscript maps, a careful distinction was made between towns whose names were formed by the addition of the suffix and those where *-ton* was part of a borrowed name. By this definition "Ironton," for example, would qualify, but "Hamilton" would not.

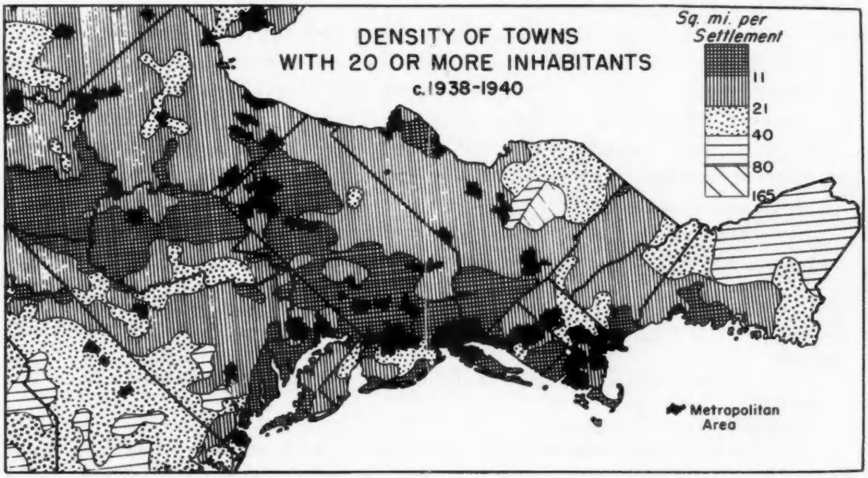

FIG. 15

eastern Pennsylvania invites further investigation. Another ostensibly universal term is *green,* for some 25 occurrences have been recorded in widely scattered portions of the study area.[57]

A clearly regionalized pattern appears in the distribution of *corner* or *corners* in the names of villages (Fig. 17), for numerous clusters occur throughout New England, New York, Ohio, northern Pennsylvania, New Jersey, and the Chesapeake Bay region, while almost no examples are found in Kentucky, West Virginia, or southern Pennsylvania. Particularly notable is the strong concentration in south-central Maine. Nothing is known of the history or cultural significance of *corner* except that it is an Americanism entirely unknown in England.[58]

A less complex pattern prevails for another Americanism, *center,* which is distributed widely, though not in vast numbers, throughout the entire northern half of the study area (Fig. 18).[59] Although the fact may not help explain the distribution, it is interesting to note that *center* frequently occurs as the designation for one of a cluster of toponymically related villages. Thus, to quote a fictional example, a "Colchester Center" may lie within a mile or two of "Colchester" which, in turn, is flanked by "North Colchester" and "South Colchester."

Other town terms with essentially New England concentrations are *village* (Fig. 19) and *common,* the latter of which is found only in Vermont, Massachusetts, and Rhode Island. In portions of western New York and northern Vermont and Maine the term *settlement* is used for some relatively diffuse groupings of houses, a usage apparently related to frontier conditions.

Two of the most important terms for settlements, *-burg*[60] (Fig. 20) and *-town* (Fig. 21), occur in nearly all sections of the study area, but for reasons that are not at all clear their major concentrations lie within the central portion. Possibly the essentially urban significance of these terms is more apposite in this region of well-developed urban culture than elsewhere. The term *city* shows an even stronger clustering within the central area (Fig. 22). This Americanism[61] is used not only for genuine cities but also as "a grandiose or anticipatory designation for a mere hamlet or village" (*DAE*). In southeastern Pennsylvania, the adjacent part of New Jersey, and southeastern New England, there appear a number of villages with the designation *square* in obvious reference to the town square around which the settlement is arranged.

Few generic terms for towns are centered in the southern portion of the study area since settlement is generally sparse and a larger than average proportion of

[57] The origin and morphological connotations of the term are obscure inasmuch as none of the dictionaries define *green* in the sense of a settlement; but it is possibly derived from "village green."

[58] The earliest citation in the *DAE* dates from 1841, but the term was certainly in use long before then.

[59] Once again the *DAE*'s earliest citation—1791—seems unreasonably recent.

[60] The term is unusual etymologically in that it may derive from German, Dutch, and French sources as well as English. It is also interesting to note that it is closely akin to *-boro.*

[61] The earliest citation dates from 1747 in New Jersey (*DAE*).

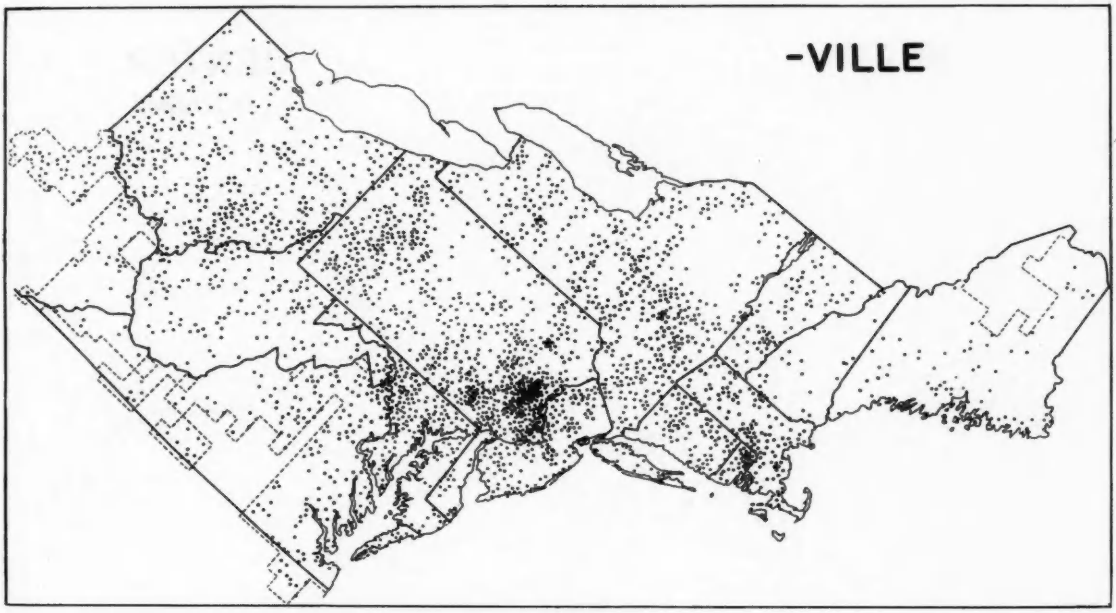

FIG. 16

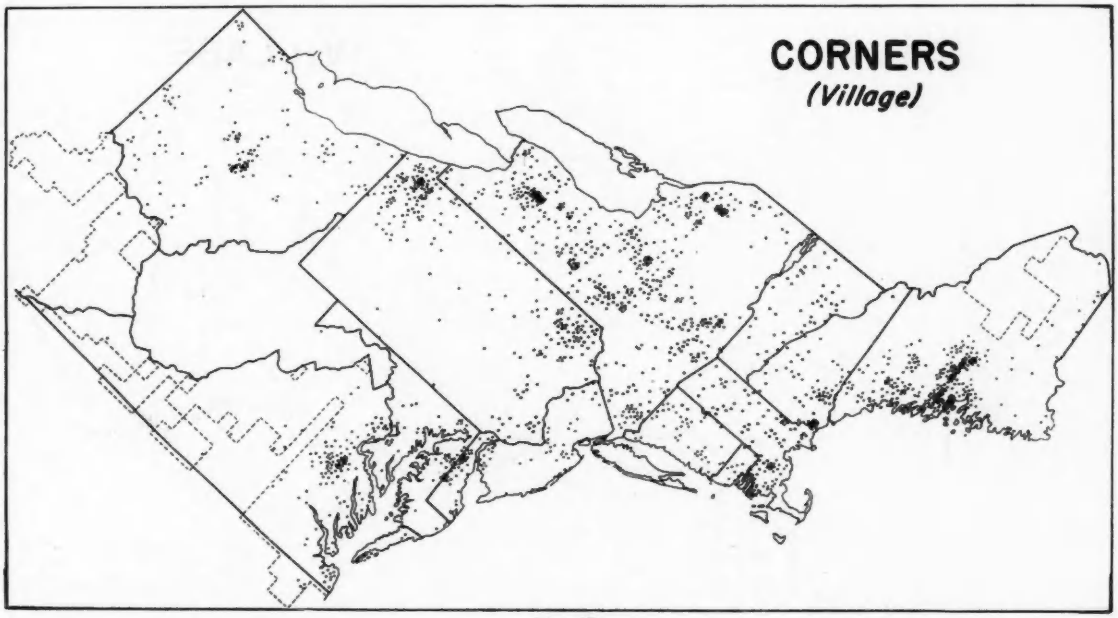

FIG. 17

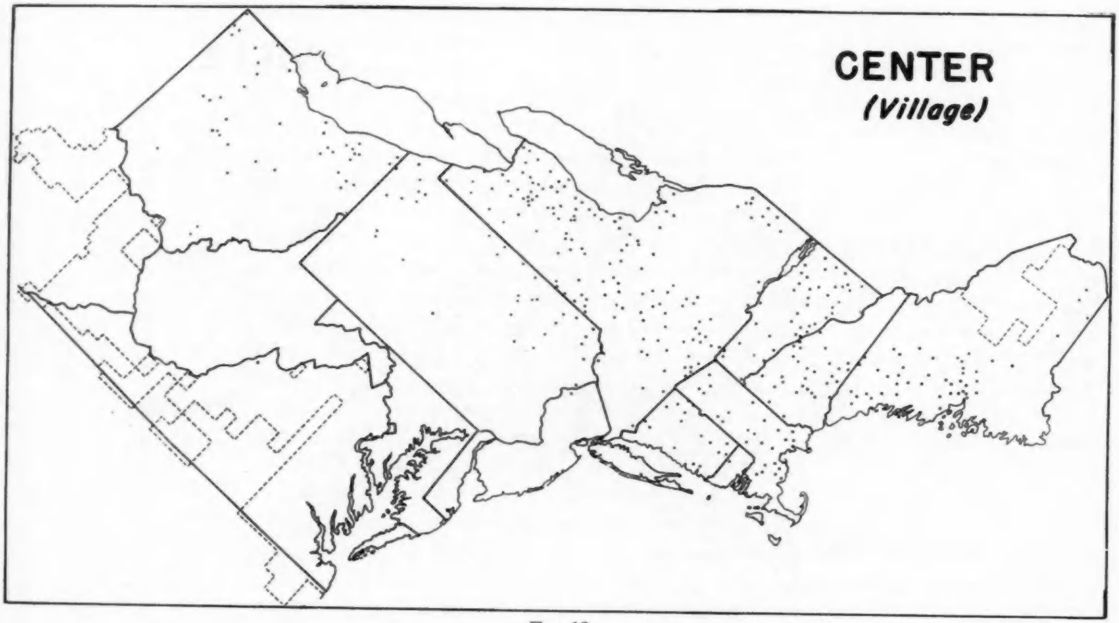

FIG. 18

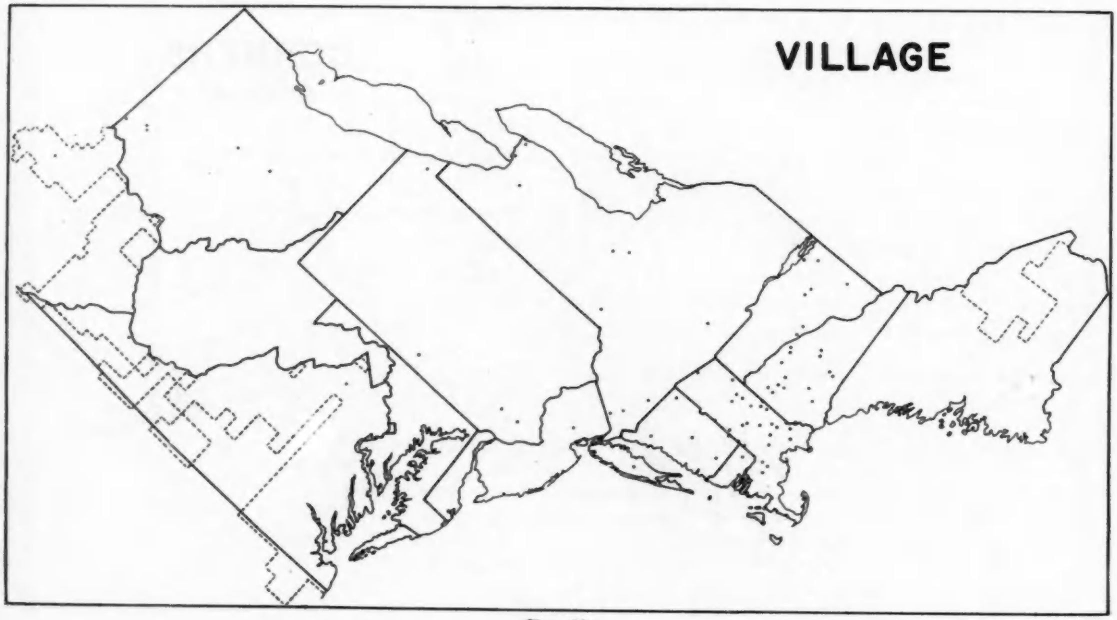

FIG. 19

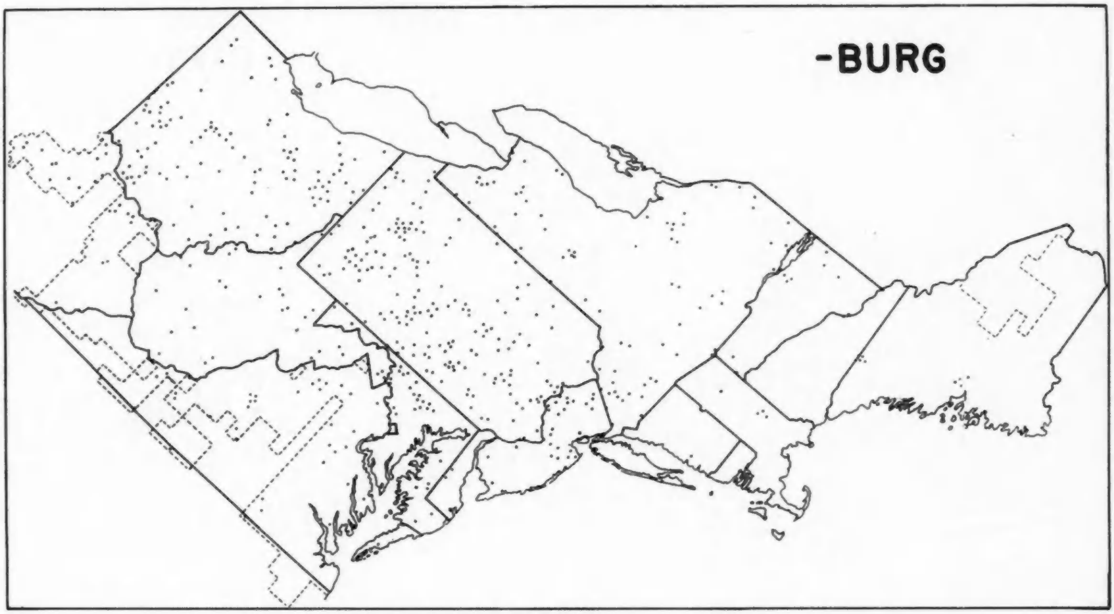

FIG. 20

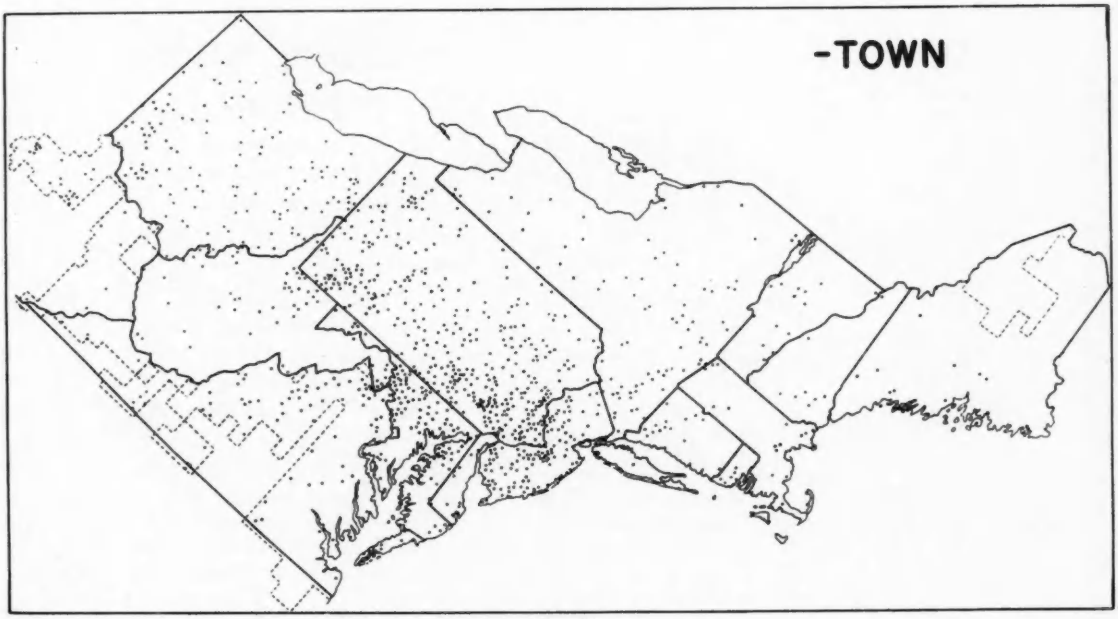

FIG. 21

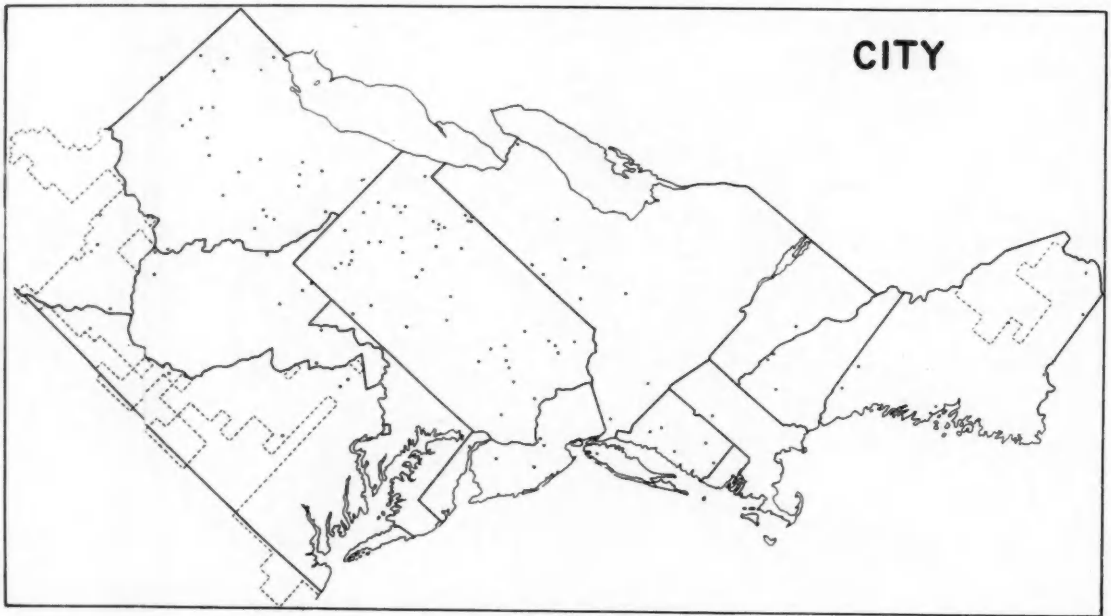

FIG. 22

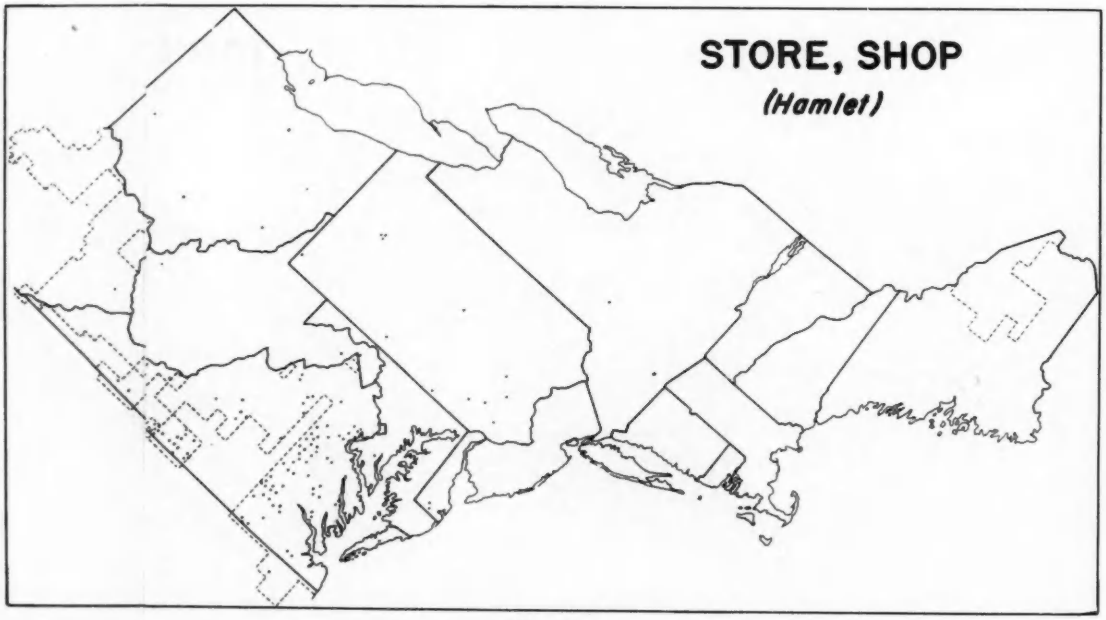

FIG. 23

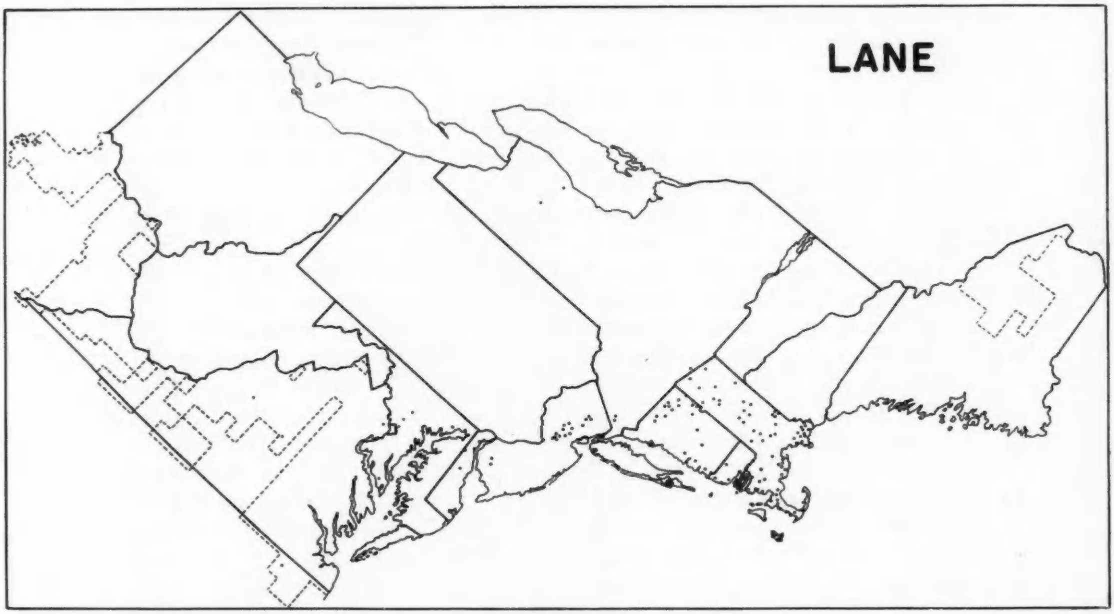

FIG. 24

places lack generic elements in their names. The term *crossroads* is one of the few, for even though scattered as far north as Maine and New York, most occurrences are in Tidewater Virginia and Delaware. Within the same Tidewater Virginia region, the term *forks* is attached to many small villages and hamlets situated at road intersections. Because of the wide intervals between genuine towns, the numerous rural stores of the South often take on certain urban functions; and if a small settlement should arise near one, it frequently receives the appellation *store* or *shop* (Fig. 23).

HIGHWAYS

Since such phenomena as bridges, wharves, farms, mills, dams, and other areally conspicuous works of man have received universal terms when they have been named by mapmakers, the only important class of artifacts remaining to be discussed is rural highways.[62] Although most of these are designated at the present time only by means of letters and numbers, a variety of generic terms for roads have survived from earlier days or have been recently revived. The most areally restricted is *tote road,* a term for "a rough temporary road for conveying goods to

[62] Under the rubric of non-material culture, some atypical terms for political units, e.g., *town* (for *township*), *borough,* and *hundred,* and for tracts of real estate, e.g., *grant, patent,* or *gore,* might logically be discussed; but their distributional traits and the factors controlling them are so special that they merit independent treatment.

or from a settlement, camp, etc." (*NED*) that occurs only in northern Maine[63] and is documented only as far back as 1862 (*DAE*). The terms ***turnpike***[64] and its derivative ***pike***[65] obviously refer to the improved toll roads constructed since the latter part of the 18th century. The contemporary distribution of the terms is markedly uneven: ***turnpike*** occurs in every state within the study area, but notable concentrations are found only in southeastern New England, the immediate hinterland of Baltimore, and in west-central Ohio; ***pike*** remains important only in the territory adjoining the Massachusetts-Rhode Island boundary, the Blue Grass region of Kentucky, and western Ohio.

Another group of road terms is current only within the older portions of the Northeastern United States, particularly New England. *Street,* the most important of these, is found in considerable profusion in the rural tracts of Massachusetts and Connecticut and in western New York, an altogether remarkable phenomenon in view of the fact that this relic of the Roman occupation of Britain has long been obsolete in the vernacular of that country.[66] *Avenue,* which has much the same distribution pattern, except for an extension into New Jersey and Maryland, has never been recorded in the sense of a rural road by lexicographers in either Great Britain or the United States. The use of *lane* for rather short public roads extends along the Atlantic Seaboard from New Hampshire to the Potomac and recurs, after a wide gap, in the Blue Grass country of Kentucky (Fig. 24). The only definition recorded for England is "a narrow way between hedges or banks" (*NED*); but in this country the *LANE* describes it as a private road and the *DAE* as a Southernism meaning "a road which has a fence on each side." The list of such terms is rounded out by *way* which occurs infrequently in southeastern New England.

CONCLUSIONS

It is evident from the foregoing series of maps and descriptions that no two of the terms studied have identical or even nearly identical patterns of distribution. This is true not only because of the areal nonequivalence of the various phenomena named, but also because of rapid and often complex linguistic shifts in many terms in a region where migration has been vigorous and settlement so recent that cultural areas have had scant opportunity to crystallize. Nevertheless, it is equally evident that the majority of terms discussed can be sorted into a few rough regional and temporal categories. First, it appears that the Atlantic Seaboard, and especially its New England sector, contains many Anglicisms and archaic terms and that it more closely resembles the home country toponymically than do the interior regions. In areas settled some time after about 1760 (Fig. 25) there is an impor-

63 Except for a single example in the anomalous north-central Pennsylvania region.

64 First recorded in England in 1748 (*NED*) and in the United States in 1785 (*DAE*).

65 Described by the *NED* as dialectal, colloquial, and an Americanism; first known adoption in the United States in 1836 (*DAE*).

66 *NED.* This dictionary's definition of *street* as "a paved road, a highway" would seem to apply. Hale's contention (*op. cit.*) that the term is used as an equivalent for hamlet in certain parts of New York and Connecticut cannot be confirmed by a study of the maps of those states.

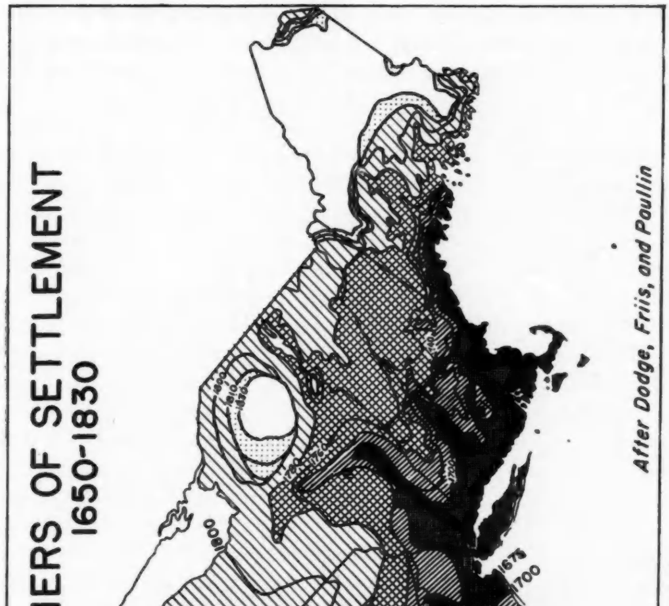
FRONTIERS OF SETTLEMENT
1650-1830
After Dodge, Friis, and Paullin

FIG. 25

tant group of Americanisms and terms with a strong frontier flavor. If one excludes the Dutch terms, which occupy a small but distinctive region, these regionalized groupings may be tabulated as follows:[67]

Old Colonial (Entire Seaboard)

Corner	Marsh (?)	Mill pond
Lane	Meadow	Pond

New England

Avenue	Common	Hill	Street
Bog	Corner	Ledge	Village
Brook	Creek (near absence of)	Mount	Way
Center			
	Heath	Pond	

Midland

-burg	Square
City	-town
Run	

South

Branch (in non-tributary sense)	Pocoson
Crossroads	Swamp (for stream)
Forks (for hamlet)	

Northern Frontier

Center	Flowage	Gully	Notch	Settlement
Cobble	Glen	Inlet	Outlet	Stream
Corner	Gorge	Mount	Pond	Tote road

Southern Frontier[68]

Branch (in non-tributary sense)	Fork (in both tributary and non-tributary senses)	Knob
Cove		Lick
Draft	Gap	Spur

It is tempting to press further and endeavor to establish definite boundaries for culture areas on the basis of place-term distributions; but such an experiment must be deferred because of the inadequacies of the map data and the means for tracing the chronological shifts in the importance and areal extent of the terms.

[67] Some terms are recorded as being characteristic of two regions. The term "Midland," used for the central portion of the study area, is borrowed from Kurath, *Word Geography of the Eastern United States.*

[68] North-central Pennsylvania may be regarded as an outlier of this region.

A variety of research problems are suggested by the provisional data presented here. Most urgent is the need for a series of careful studies of the toponymy of a selected group of communities that will include generic terms, specific names, and vernacular topographic language and will treat these subjects in their full geographic and historical context. In addition, much is to be gained by investigating the historical geography of important individual generic terms over their full North American range. Although abundant documentary materials exist for the study of generic terms in Great Britain, their analysis has been neglected in favor of an exhaustive survey of all individual specific names of the country.[69] If this deficiency were to be remedied, the study of American toponymy could be greatly advanced. Corollary to such studies, there should be research on the source, routing, and destination of the settlers of the United States, with particular attention to the culture and the social psychology of those who were the most active namers.

Among other unanswered problems is the interaction of differing European cultures in the United States. Why have no minority cultures except the Dutch survived in the generic terms of the study area, and specifically why the failure of German, Swedish, and aboriginal terms?[70] Furthermore, why have these non-English cultures survived in specific names? And what is the relationship between specific and generic nomenclature not only as regards cultural survival but also in a more general sense? A host of interesting linguistic problems with geographic overtones are offered by generic terms—particularly the process of change in the meaning of old terms and the invention of new ones in the transfer of settlers overseas to a relatively similar physical environment and the further changes with the penetration of the interior. The paramount problem, however, and one that may never be fully answered, is the nature of the inter-relationsips among toponymy, other cultural phenomena, and the physical environment. It is to be hoped that some way can be found to approach this problem so as to delimit accurately the past and present culture areas of the nation and to document the whole marvelously intricate process of cultural evolution.

[69] The English Place-Name Society's *Survey of English Place-Names.* The closest approach to a discussion of generic terms is found in *Introduction to the Survey of English Place-Names: Part II, the Chief Elements Used in English Place-Names* (Cambridge, 1924).

[70] There are, of course, isolated exceptions, such as *pocoson,* a single case of *-berg* (for mountain in the Pennsylvania German country), and a few *lacs* and *rivières* near the Canadian border. In other parts of the nation Spanish and French terms may locally assume great importance. See Raup, *op. cit.;* West, *op. cit.;* Mary Austin, "Geographical Terms from the Spanish," *American Speech,* Vol. VIII, No. 1 (1933), pp. 7–10; and Edward E. Hale, "Geographical Terms in the Far West," *Dialect Notes,* Vol. VI, Pt. 4 (1932), pp. 217–34.

USE OF STRATIFIED RANDOM SAMPLES IN A LAND USE STUDY*

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THIS paper demonstrates the use of stratified random sampling and statistical analysis applied to a land-use problem. The objectives of the inquiry in which these techniques were used were (1) to locate and map the swamps and marshes of eastern Wisconsin (Fig. 1),[1] (2) to map the utilization of this land, and (3) to evaluate its significance to the economy of the region. Only the first two objectives will be treated in this paper. Although the term "wet land" has been used to designate the subject under consideration, the term "organic soils" could have been used as well. It was found in the field that, in places that had detailed soil map coverage, the writer's classification of "wet land" included only those areas on the map designated as peat or muck.

USE OF SAMPLES

Preliminary investigations indicated that there were about a million acres of poorly drained land in the area. This type of land can be found in all except one of the almost 300 townships which make up the hundred thousand square miles of eastern Wisconsin. The amount and distribution of this land, as well as limited time and funds, clearly indicated that not all of it could be studied at first hand. Some form of sampling was indicated. A search of the literature revealed that not much sampling for geographic research had ever been done. True, isotherms, isohyets, contours, and the like must of necessity be based on samples, but they represent ingredients of the landscape which change from place to place at a more or less even rate. Furthermore, these changes are changes in degree rather than changes in kind. Land use, on the other hand, changes abruptly from one kind to another.

This fact, probably more than any other, has hindered the development of sampling procedures for land-use study. Traverses, really a form of sampling, have

* The author is especially indebted to Professor Arthur H. Robinson of the Department of Geography at the University of Wisconsin.

** This manuscript was prepared when the author was assistant professor of geography at the State University of Iowa.

[1] Eastern Wisconsin is defined as that part of the state having Late Wisconsin drift and lying east of the Magnesian Escarpment. Practical considerations of the research problem dictated that the western boundary coincide with political boundaries. Milwaukee County as well as parts of Brown, Calumet, and Outagamie counties, all parts of eastern Wisconsin, are omitted from the study because of lack of data. Included within the problem area are thirteen whole counties and parts of eleven others. A "swamp" is distinguished from a "marsh" by the fact that it is wooded. A marsh has no trees but may have brush.

many variations and are useful for certain purposes.[2] A comparatively short traverse, properly laid out across the grain of the landscape, can be expected to reveal how much land is in a given use, but by itself it is not very helpful in telling how the utilizations are distributed. Closely spaced foot traverses, such as used by the Wisconsin Land Economic Inventory,[3] can answer both the "how much" and "where" questions, but one individual could never hope to cover a large field area by this method. In addition, the prospect of making traverses across swamps and marshes was not very attractive.

The problem could have been solved by air photo interpretation, but the only such photography available at the time was made in the late 1930's. Though still good for identifying the wet land, it was inadequate for a current land-use study because of the many changes which have taken place in the intervening years.

The possibility of making broad generalizations based upon observations of a few "typical" areas was ruled out from the start. If one knew enough about an area to recognize that which is truly typical, there would be no point in doing the research at all because the facts would already be known to the investigator. Each investigator is allowed much leeway in choosing units for detailed study. However, if one plans to use statistical analysis, he must choose his sample in such a way as to give every individual in the universe an equal chance of being chosen.

SIZE OF THE SAMPLE

Sampling methods are usually used because of the impracticality of studying the universe. The smaller the sample is, however, the more necessary it is that the individuals which make it up be chosen with care. In light of the analysis techniques to be used later, it was decided that towns[4] were to be the individual

[2] See C. C. Colby, "The Railway Traverse as an Aid in Reconnaissance," *Annals,* Association of American Geographers, Vol. 23 (1933), pp. 157–164; G. D. Hudson, "Methods Employed by Geographers in Regional Surveys," *Economic Geography,* Vol. 12 (1936), pp. 98–104; Malcolm J. Proudfoot, "Sampling with Traverse Lines," *American Statistical Association Journal,* Vol. 37 (1942), pp. 265–270.

[3] The Wisconsin Land Economic Inventory, organized in 1928 and expanded when funds became available in the 1930's, sought to map all of the land cover in the state except that in Milwaukee County. Data for the maps were gathered by field men who made foot traverses one eighth of a mile apart in the southern counties and one quarter of a mile apart in some of the sparsely settled northern counties. These field men used a pace scale to record the distance traveled through each specific type of cover. The plan was to have the traverse data incorporated into maps, but before maps could be made for all counties, the work slowed down considerably because of lack of funds. Published maps at a scale of one inch to the mile are available for most of the counties in eastern Wisconsin. In addition to the published maps, there are a number of unpublished sheets existing only in manuscript form. These are on file at the Land Economic Inventory office in Madison. The maps were used in this study and proved valuable both in the field and in the office. Indicated, in addition to the usual cultural features, are all of the various kinds of forest cover, brush, upland pasture, cropland, and poorly drained land.

[4] As used in this paper, the word "town" means a minor civil division, as distinguished from a "township," which is a measure of land. Most towns are composed of whole townships, but some are larger and some smaller.

units in the sample. Towns are the smallest division of land for which statistics are gathered. In Wisconsin more data are available on a town basis than in most states. Information contained in the 1945 *Census of Agriculture* has been published on a town basis.[5] Also, town assessors' records have been consolidated and give much valuable data concerning land use on a year to year basis.[6]

Limited time and funds dictated that only ten towns could be studied in detail. A sample of this size would include between three and four percent of the universe, which had 293 towns. Admittedly this is a small sample, but size alone is not the sole measure of sample validity. For instance, prices paid for grain and butterfat are based on samples much smaller than that. If there is any basis at all for the small-sample theory, ten towns should adequately represent eastern Wisconsin, if a proper procedure is followed in choosing these towns. The aim of any sampling procedure is to draw sample units which, when grouped together, possess the same degree of diversity as the universe from which drawn.[7] Actually, eastern Wisconsin is not as diverse as one might expect. It is a cuestaform plain, underlain by limestone, covered with new glacial drift, and it is devoted to the dairy economy. This homogeneity made the choice of a representative sample much simpler than it would have been had the area been more diverse.

The area is not so homogeneous, however, as to encourage complete random choosing of such a small sample. There is a gradation of agricultural intensity from high values in the south to lower values in the north, as indicated by percent of land in farms, percent of farm land in crops, value of farm land, and other measures. It was assumed that such a situation with regard to land in general would be reflected in the intensity to which wet lands were utilized.

INVESTIGATIONS PRIOR TO CHOOSING THE SAMPLE

A close examination of the distribution of the wet land as revealed by the original surveyors' maps indicated that the amount of wet land per town ranged from over 24,000 acres in the wettest town to less than 100 in the driest.[8] A comparison of the surveyors' maps with those made by the Land Economic Inventory, eighty to a hundred years later, showed that these two sources disagreed widely as to the amount of wet land in some of the towns, the Land Economic Inventory more often than not giving the smaller acreage. This is understandable because the Land Economic Inventory did not consider hay marsh, drained cropland, or, usually, cleared swamp land as wet land. Later field investigation revealed another reason

[5] Wisconsin Crop and Livestock Reporting Service, *County Agriculture, Bulletin 202 and Supplements* (Madison, Wisconsin, 1947–48). There is a separate bulletin for each county.

[6] The town assessors' records are on file in the office of the Federal-State Crop Reporting Service located in the state capitol, Madison, Wisconsin.

[7] For a good elementary treatment of the sampling theory, see George R. Davies and Dale Yoder, *Business Statistics* (2d ed., 1941). The same or a similar reference will also prove useful in following the methodology used later.

[8] These documents are on file in the office of the Commissioner of Public Lands in the state capitol, Madison, Wisconsin. They date from the 1830's, 1840's and 1850's.

for this. The surveyors, who were not required to go inside a square mile of land while surveying it, often mistakenly inferred that a swamp extended all the way across a section when actually it didn't. Several surveyors were prone to mark some land as impassable swamp and not "run the section line" at all, even though a fairly large "island" of upland timber would have been discovered if the line had been run. Very puzzling, at first, were the cases in which the Land Economic Inventory showed more wet land than the original survey. This occurred mainly because many of the smaller marshes lying some distance from a section line went unnoticed and unmapped by the surveyors, but were mapped by the Land Economic Inventory.

CHOOSING THE SAMPLE

The facts uncovered during the preliminary investigations were invaluable in setting up the controls to govern the choice of sample towns. The first step was to change the number of units in the universe from 293 to a more manageable 290. This was done by eliminating one town in which the Land Economic Inventory found no wet land at all and combining two pairs of smaller towns into two psuedo-towns. The pseudo-towns were hereafter treated as one town and the area was thought of as having 290 towns.

The second step was to place the 290 towns in an array according to the amount of wet land they had at the time of the original survey. The town having the least wet land was placed at the head of the array, and the one having the most was placed at the foot. The whole array was divided into groups by counting off the first fifty-eight to form the first group, the second fifty-eight for the next group and so on until five groups of towns were formed. By stratifying a diverse universe such as this and choosing an equal number of units from each strata, one can expect to have a sample more representative of the universe than one chosen at random.

The third step was to rearrange the towns within each of the five groups into arrays, with the town having the most decrease in wet land acreage between the time of the Land Survey and the Land Economic Inventory at the head of the list, and the town having the most increase at the foot of the list. Each group was then divided into two parts by counting off the first twenty-nine for a "much decrease" subgroup leaving the last twenty-nine to form a "little decrease" subgroup. The plan was to draw one town from each of the ten subgroups to form the sample.

The fourth step was to divide a minor civil divisions map into southern, middle, and northern thirds with the boundary lines running as nearly east-west as town lines would permit. The southern and middle thirds had one hundred towns each and the northern third with larger towns had ninety. It was planned that at least three sample towns should come from each third with the tenth sample falling wherever chance would place it. However, this control was not to be placed into operation unless it was found after the sample was drawn that one of the thirds had less than three or more than four sample towns. If that situation had arisen the entire sample would have been rejected and a new one chosen which met the provisions of this control.

Having established the controls, twenty-nine filing cards were numbered consecutively from one to twenty-nine and thoroughly shuffled. A card was then drawn to indicate which town of the first subgroup was to be a part of the sample. It was

TABLE I

WET LAND ACREAGE IN THE TEN SAMPLE TOWNS ACCORDING TO THREE SOURCES

Sample town, and county from which drawn	Original survey acreage	Land Economic Inventory acreage	Actual acreage (writer's field maps)
Aztalan, Jefferson	1,220	1,200	1,558
Bailey's Harbor, Door	5,250	4,232	6,905
Dunn, Dane	1,720	3,210	2,746
Hartland, Shawano	7,000	2,994	3,605
Linn, Walworth	1,520	659	825
Lowell, Dodge	10,250	11,547	11,007
Nepeuskum, Winnebago	4,900	5,489	4,082
Oconomowoc, Waukesha	3,000	2,391	3,376
West Bend, Washington	710	1,252	1,252
Woodville, Calumet	2,930	1,186	1,835
Total	38,500	34,160	37,191

number 21 and accordingly the twenty-first town in this subgroup, Aztalan in Jefferson County, became the first sample town. The card was returned to the

TABLE II

SAMPLE AND CHECK SAMPLE COMPARED*

Item compared	Sample	Check sample
Total land acreage (C)**	207,000	222,000
Wet land acreage (S)	38,000	38,000
Wet land (S) % of total area (C)	18.3%	17.1%
Wet land acreage (L)	34,000	29,000
Wet land (L) % of total area (C)	16.4%	13.0%
Farm land acreage (C)	188,000	198,000
Farm land (C) % of total area	91.0%	89.2%
Number of farms (C)	1,670	1,720
Average size of farm (C)	113	115
Cropland acreage (C)	107,000	113,000
Cropland (C) % of farm land (C)	56.9%	57.1%
Plowable pasture (C) % of farm land (C)	11.3%	11.9%
Farm woodland (C) % of farm land (C)	9.3%	9.3%
Other farm land (C) % of farm land (C)	21.2%	20.7%
Corn acreage (A) % of cropland (C)	30.0%	29.3%
Tame hay acreage (A) % of cropland (C)	32.7%	32.5%
Pasture not wooded or plowed (A) % of farm land (C)	12.1%	10.6%

* The towns in the check sample are Arlington, Columbia; Harrison, Calumet; Dunkirk, Dane; Randall, Kenosha; Vinland, Winnebago; Abrams, Oconto; Erin, Washington; Columbus, Columbia; Lincoln, Kewaunee; and Palmyra, Jefferson.

** A = assessors' reports; C, census; L, Land Economic Inventory; S, land survey.

pack, the pack shuffled again, and another card was drawn to determine which town in the second subgroup would be added to the sample. The process was repeated until a sample had been drawn from each subgroup. The towns thus chosen to be

the sample are listed together with their acreage of wet land (Table I) and shown in their location in eastern Wisconsin (Fig. 1).

Next, a check sample of ten towns was chosen by the same method to serve as

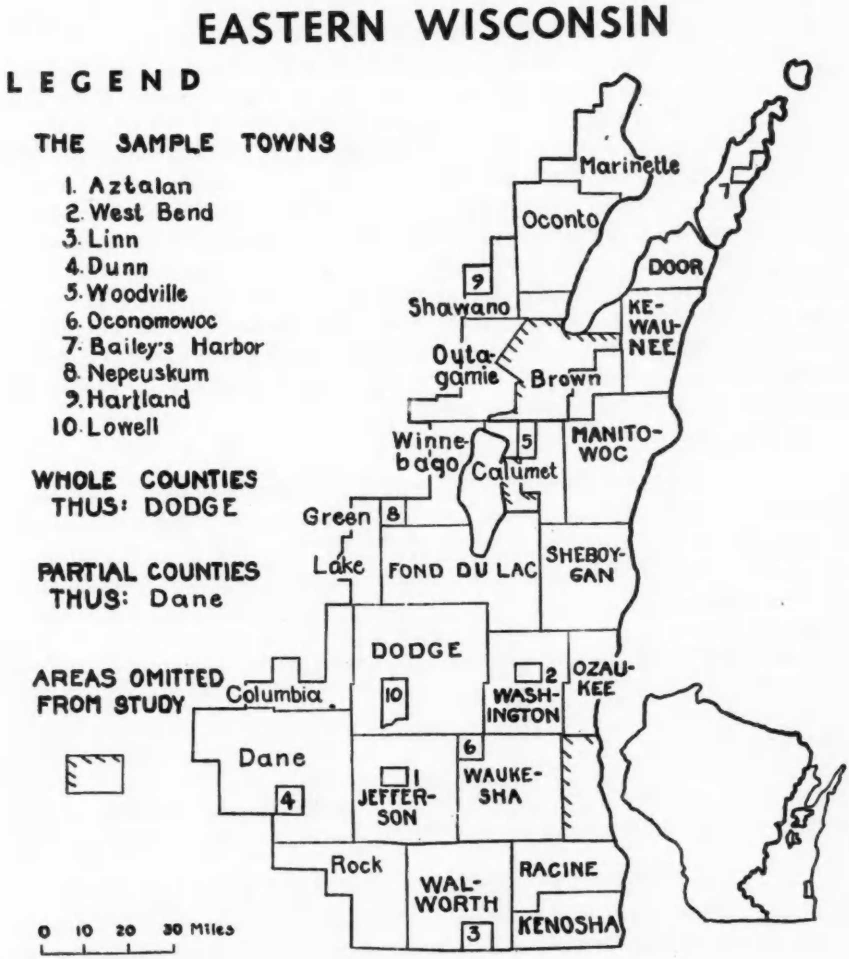

FIG. 1

a basis of comparison. It may be argued that if two stratified random samples compare well with regard to known data, they could also be expected to compare well with regard to unknown data and that either or both would be representative of the universe. Such a comparison (Table II) revealed that there was indeed close

agreement, and the field study of the sample was begun with strong hopes for success.[9]

MAPPING LAND USE

Each of the ten sample towns was visited and the utilization of the wet land was recorded on 1 : 20,000 vertical aerial photographs. The recorded land was classified as wasteland, open pasture, pastured swamp hardwoods, non-pastured swamp hardwoods, tamarack, white cedar, balsam, fir, hay marsh, and cropland. If the land was in crop, notation was made of the kind of crop.

In order for a given piece of land to be classed as wet, and thus recorded, a few simple requirements had to be met. The surface had to appear flat to the eye, have a high percentage of humus, and be black in color. The presence of marsh or swamp vegetation was also a valuable clue, as was the presence of drainage ditches. It was also noted that the contact between dry upland and wet bottom land occurred at abrupt changes in slope. This knowledge greatly facilitated the drawing of boundaries on the photographs, because the changes in slope appeared on the photographs as definite changes in tone.[10] After the field data were gathered, acreages devoted to various uses were measured from the photographs (Table III) with a dot planimeter, and recorded on analysis paper.

TABLE III

WET LAND UTILIZATION IN THE SAMPLE TOWNS, BY ACRES (BASED ON FIELD DATA)

Sample town	Swamp	Individual agricultural uses			Swamp and agricultural uses	Wasteland	All wet land
		Open pasture	Wild hay	Cropland			
Aztalan	159	1,180	23	105	1,467	91	1,558
Bailey's Harbor	6,392	55	0	0	6,447	458	6,905
Dunn	45	828	6	35	914	1,832	2,746
Hartland	2,879	528	20	61	3,488	117	3,605
Linn	0	657	15	38	710	115	825
Lowell	709	5,775	999	794	8,277	2,730	11,007
Nepeuskum	4	1,580	365	48	1,997	2,085	4,082
Oconomowoc	712	1,697	64	301	2,774	602	3,376
West Bend	630	470	3	20	1,123	129	1,252
Woodville	1,016	550	2	108	1,676	159	1,835
Total	12,546	13,320	1,497	1,510	28,873	8,318	37,191

ESTIMATING TOTAL AMOUNT OF WET LAND

A comparison of the total acreages of wet land yielded by the three sources (Table I) would seem to indicate that fairly good estimates of the actual acreages

[9] The close agreement of two samples in regard to several items does not prove beyond all shadow of a doubt that they will agree as well on other points, but it is highly likely. It is true, however, that if two samples do not compare well with regard to known data, there is little hope that they will have much agreement insofar as unknown characteristics are concerned.

[10] Maps of the Soils Survey and Land Economic Inventory as well as tracings of the Land Survey maps were used in the field. It was never necessary to record any wet land not mapped on at least one of these three maps, but the shapes of many areas were changed.

in the towns not chosen as sample units could be made by averaging the figures of the original survey and the Land Economic Inventory. However, consideration of some of the individual towns dispels this hope and prompts one to search further for a method by which actual acreages may be estimated. Further study of the table as a whole suggests that somewhat better estimates might be made by using the Land Economic Inventory figures alone. Yet even such a method would not employ the available data in the most useful manner.

When considering the relationship between Land Economic Inventory acreages and actual acreages in groups of towns rather than in all ten at once, the relationship becomes more apparent. When the five "much decrease" towns (Table IV) were separated from the others, it was immediately observed that in every case the Land Economic Inventory acreages were lower than those observed in the field.

TABLE IV

WET LAND ACREAGES IN THE "MUCH DECREASE" TOWNS, BY VARIOUS SURVEYS

Sample town	Land survey	Land Economic Inventory	Field maps
Aztalan	1,220	1,200	1,558
Bailey's Harbor	5,250	4,232	6,905
Hartland	7,000	2,994	3,605
Linn	1,520	659	825
Woodville	2,930	1,186	1,835
Total	17,920	10,271	14,728

Because this is true with regard to half of the sample, it may be assumed that it is substantially true with regard to half the universe represented by these five towns. After that assumption is made, the next step is to devise some means by which Land Economic Inventory acreages may be used to make estimates of the total wet land acreage in each of the one hundred and forty "much decrease" towns not chosen as sample units. This is most easily done by drawing a trend line on a scattergram plot of actual acreages and Land Economic Inventory acreages (Fig. 2). The exact position taken by this trend line is determined by computing the "least squares." Such a line is the best possible straight trend line for expressing the relationship which exists. The same computation can serve as a base for deriving an empirical formula which expresses the relationship in mathematical terms.

In using this device for making estimates, the Land Economic Inventory acreage of wet land in an individual town is found on the bottom line and a perpendicular is projected to the point where it intersects the trend line. The estimate is then read from the vertical axis at the height indicated by the intersection. The formula expressed by the nomograph (Fig. 2) is $T = 1.59X - 3.2$, with T equaling the estimate in hundreds of acres of wet land and X representing the Land Economic Inventory acreage of wet lands in hundreds. Formulas expressing the relationship between actual and Land Economic Inventory acreages in the "little decrease," "much decrease," southern, middle, and northern towns appear in Table V. In

Nomograph for Estimating the Amount of Wet Land in Towns Having Much Decrease in Wet Land Between 1850 and 1930

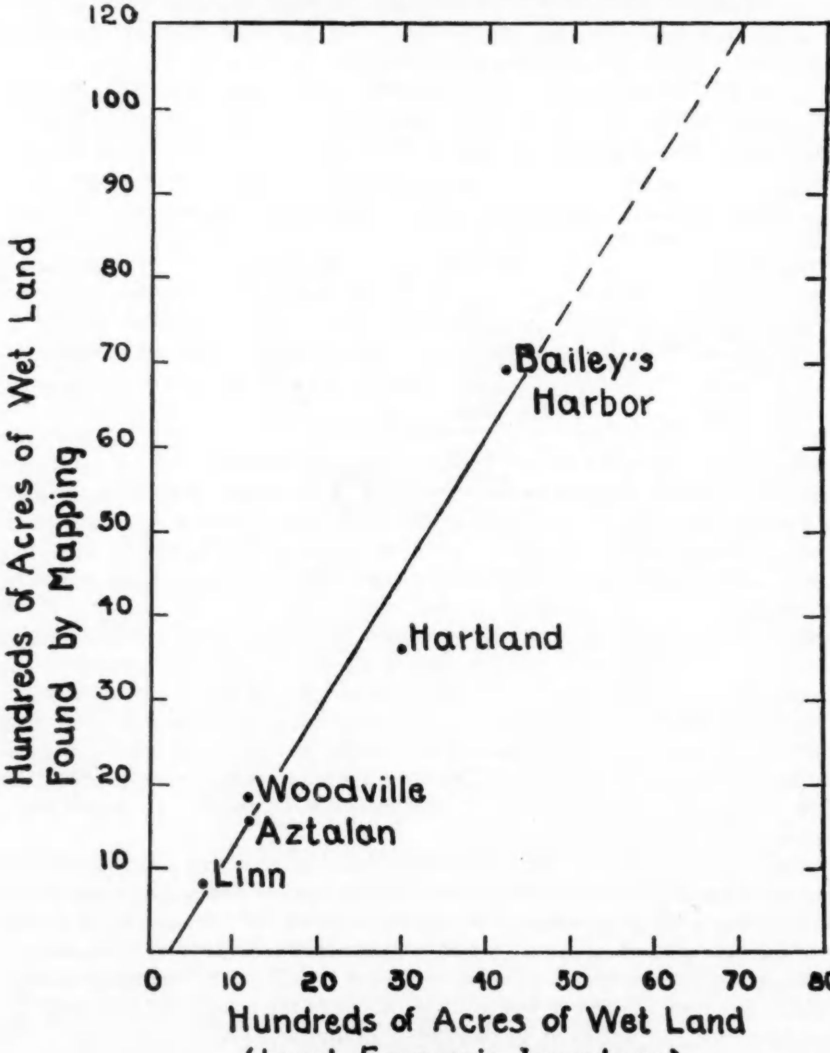

FIG. 2

TABLE V

SUMMARY OF RELATIONSHIP BETWEEN LAND ECONOMIC INVENTORY AND ACTUAL ACREAGES OF WET LAND

Group of sample towns	Land Economic Inventory acreage of wet land	Actual acreage of wet land found in the field	Relationship as expressed by prediction formula*
Much-decrease towns Aztalan, Bailey's Harbor, Hartland, Linn, Woodville	10,271	14,728	T = 1.59 X − 3.2
Little-decrease towns Dunn, Lowell, Nepeuskum, Oconomowoc, West Bend	23,889	22,463	T = .906X + 1.7
Southern towns Aztalan, Dunn, Linn, Oconomowoc	7,460	8,505	T = .867X + 5.1
Middle towns Lowell, Nepeuskum, West Bend	18,288	16,341	T = .96 X − 4.1
Northern towns Bailey's Harbor, Hartland, Woodville	8,412	12,345	T = 1.62 X − 4.2

* T equals the estimate of wet land in hundreds of acres, and X equals the Land Economic Inventory acreage of wet land in hundreds.

making an estimate of wet land acreage in a town not chosen as a sample, two of the five formulas were used. The choice of formulas was determined by the classi-

TABLE VI

ESTIMATES OF WET LAND ACREAGES IN THE SAMPLE TOWNS (IN HUNDREDS OF ACRES)

Sample town	Land Economic Inventory acreage	Much or little decrease	First estimate, according to much or little decrease formula	Southern, middle, or northern	Second estimate, according to geographical location	Final estimate (first and second estimates averaged) T*	Actual acreage (writer's field maps) Y*
Aztalan	12.0	M	15.9	S	15.5	15.7	15.6
Bailey's Harbor	42.3	M	64.1	N	64.3	64.2	69.0
Dunn	32.1	L	30.7	S	32.9	31.8	27.5
Hartland	29.9	M	44.4	N	44.2	44.3	36.0
Linn	6.6	M	7.3	S	10.8	9.0	8.2
Lowell	115.5	L	106.3	M	106.8	106.6	110.1
Nepeuskum	54.9	L	51.4	M	48.6	50.0	40.8
Oconomowoc	23.9	L	23.3	S	25.8	24.6	33.8
West Bend	12.5	L	13.0	M	7.9	10.4	12.5
Woodville	11.9	M	15.7	N	15.1	15.4	18.4
Total	341.6		372.1		371.9	372.0	371.9

* Probable error of estimate (Y–T) = 620 acres; standard error of estimates (0.6745 times 620) = 418 acres. See fn. 11.

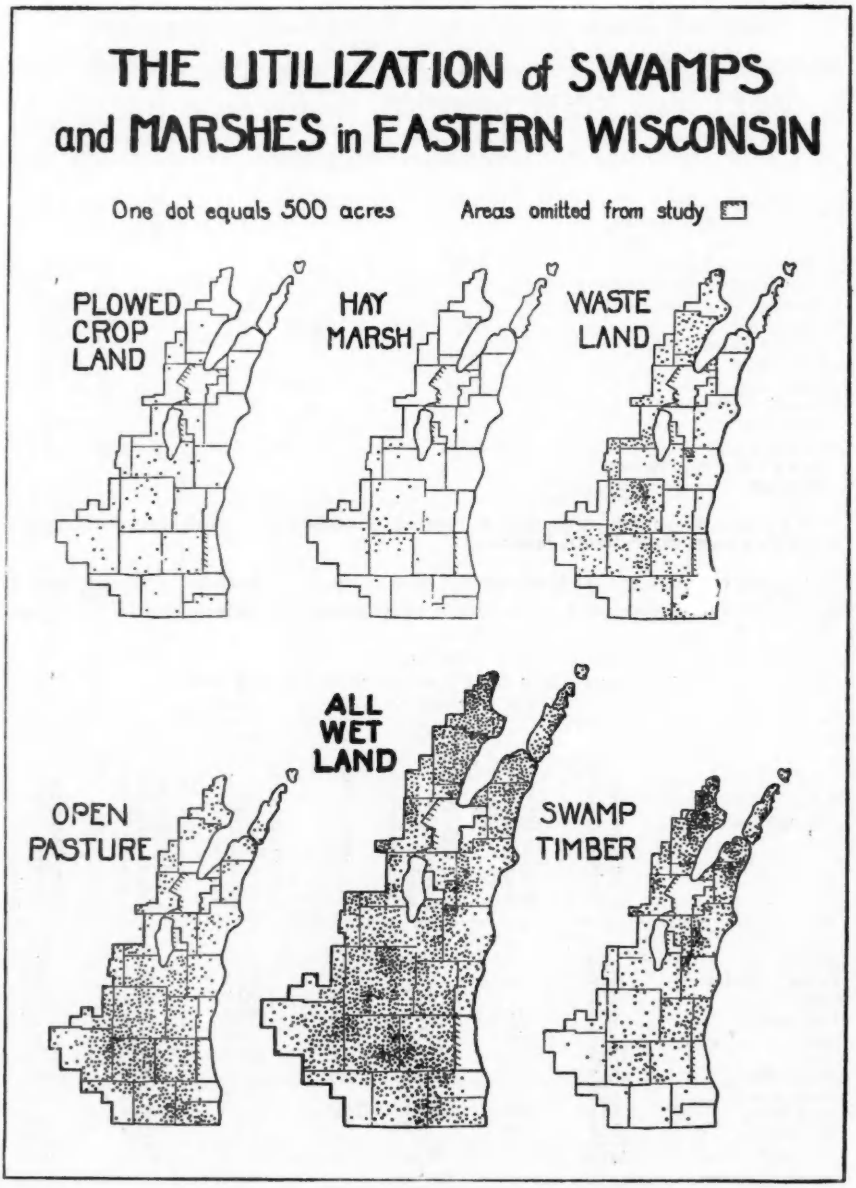
THE UTILIZATION of SWAMPS and MARSHES in EASTERN WISCONSIN
One dot equals 500 acres
Areas omitted from study
PLOWED CROP LAND
HAY MARSH
WASTE LAND
ALL WET LAND
OPEN PASTURE
SWAMP TIMBER

FIG. 3

fication of the town as showing "much" or "little" decrease and its southern, middle, or northern location. The estimates obtained from the two formulas were averaged to make a final estimate. County estimates and estimates for eastern Wisconsin as a whole were made by adding town estimates (Table VI).

TABLE VII

ESTIMATED ACREAGES OF WET LAND IN VARIOUS USES IN EASTERN WISCONSIN

Counties and partial counties in eastern Wisconsin	Swamp	Open pasture	Marsh hay	Cropland other than hay marsh	Waste-land*	All wet land
Brown	11,000	1,300	0	680	6,770	19,750
Calumet	14,000	4,300	350	500	250	19,400
Columbia	2,000	12,700	490	760	-250	15,700
Dane	2,000	36,800	1,620	3,920	17,560	61,900
Dodge	9,000	52,900	7,240	6,900	45,510	121,550
Door	50,000	7,000	100	40	1,860	59,000
Fond du Lac	10,000	31,900	780	5,570	9,100	57,350
Green Lake	1,000	5,800	730	720	7,550	15,800
Jefferson	14,000	42,100	5,470	2,200	19,930	83,700
Kenosha	600	14,600	260	1,140	6,050	22,650
Kewaunee	33,000	3,800	0	710	290	37,800
Manitowoc	38,000	9,300	370	230	4,950	52,850
Marinette	52,000	7,900	0	60	6,090	66,050
Oconto	43,000	6,900	120	470	16,760	67,250
Outagamie	16,000	6,700	140	1,080	5,780	29,700
Ozaukee	8,000	2,700	130	50	1,220	12,100
Racine	800	11,900	10	180	3,460	16,350
Rock	500	10,700	610	80	-2,140	9,750
Shawano	9,000	4,000	0	820	2,980	16,800
Sheboygan	16,000	10,100	40	1,030	9,380	36,550
Walworth	1,000	30,500	300	2,210	8,840	42,850
Washington	18,000	17,600	450	1,100	3,850	41,000
Waukesha	10,000	34,400	360	3,300	12,990	61,050
Winnebago	2,000	7,200	1,100	1,000	10,900	22,200
Total	360,900	373,100	20,670	34,750	199,680	989,100

* The negative acreages listed for Columbia and Rock counties should be no cause for alarm. As illustrated in Table XII, estimated wasteland acreages result when estimates of utilized land are subtracted from the previously made estimate of total wet land. Either the estimates of total wet land were low, or the estimates of some of the uses were high. In any event, the counties do not actually have much wasteland. The situation is analogous to many weather forecasts. For instance, "moderate north winds" are predicted but slight south winds result. This often happens near a front. In the case of these wasteland estimates the "front" is the boundary of eastern Wisconsin which runs through these two counties.

Because it is well to know how accurate estimates made in this manner are, the reliability of the method was tested by comparing actual and estimated acreages of wet land in the sample towns. Table VI, in addition to illustrating the application of the prediction method, contains the necessary data for testing its accuracy. The standard error is 619 acres and the probable error is 418 acres.[11]

[11] Wherever errors of estimate are stated in this paper, use is made of N-2 degrees of freedom. It is felt, though, that this procedure actually yields errors of estimate which are too large. See Frank Yates, *Sampling Methods for Censuses and Surveys* (London: Charles Griffin and Company, 1949), p. 192.

There is no reason to expect that the over and under estimates of wet land would not distribute themselves in a random fashion with regard to both magnitude and geographical location. If it may be assumed that such scattering did occur, the dot map of all wet land (Fig. 3) and the tabulation of county estimates (Table VII) should be quite accurate. The same reasoning applies to the dot maps, and tabulations of individual uses argue for their accuracy as well.[12]

SWAMP

There are about 361,000 acres of swamp in eastern Wisconsin (Table VII). Although much of this land has been cleared from time to time, it has usually been allowed to grow back to trees. Most of the information used in making the map of swampland was available from the Land Economic Inventory, and, except for minor adjustments, was used in its original form. Swamps usually lie in the northern and eastern parts of the region (Fig. 3). Other wet land uses are more common in the western and southern portions.

OPEN PASTURE

Predictions concerning the amount and distribution of open wet pasture rest upon relationships existing in the sample towns between open pasture acreage and two categories of information available for all towns. Well over three quarters of all wet pasture found in the sample was located on surface which is given the designation of "grass marsh" by the Land Economic Inventory. Furthermore, no grass marsh was discovered which was not in pasture. Thus, estimates of grass marsh made by the Land Economic Inventory contain some but not all of the wet open pasture. The town assessors' records list the number of acres of "pasture other than wooded or plowed." Wet open pasture is of course included here, but so is such other land as lanes, stump pasture, and rough upland pasture.

If an estimate is made of grass marsh acreage and added to the assessors' acreage of "pasture other than wooded or plowed," the result is an index number which has a highly significant relationship to actual acreages of poorly drained pasture (Table VIII). The estimate of wet pasture acreage was made by the use of a nomograph which expressed visually the equation $T = .487X - 2.2$, with T equaling the estimate in hundreds of acres and X equaling the index number in hundreds.

A very high degree of confidence can be placed in the estimates of the amount and distribution of wet pasture (Table VII and Fig. 3). The county acreage of grass marsh, which is the largest contributor to total wet pasture acreage, correlates to the extent of 0.97 with the wet pasture estimates (Table IX). If the over esti-

[12] The first copies of the dot maps had town lines and were based on town estimates. Town lines were not drafted on the final plate because they would have detracted from the visual quality of the illustration. The towns in Wisconsin are arranged in a more or less rectangular pattern, and the laws of probability favor an error of estimate in one town being compensated for in one of the towns which adjoin or corner on it.

TABLE VIII

DATA RELATED TO WET PASTURE ACREAGE IN THE TEN SAMPLE TOWNS

Sample town	Hundreds of acres of pasture "other than wooded or plowed" (Assessors')	County's per cent of wet land in grass marsh (Land Economic Inventory)	Hundreds of acres of wet land (Land Economic Inventory)	Hundreds of acres of grass marsh (II times III)	Index number (I plus IV) X	Hundreds of acres of wet pasture $T = .487X - 2.2$ T	Hundreds of acres of wet pasture recorded in the field
	I	II	III	IV	V	VI	VII
Aztalan	10	43	12	5	15	5	12
Bailey's Harbor	8	3	42	1	9	2	1
Dunn	25	49	32	16	41	18	8
Hartland	19	2	30	1	20	8	5
Linn	15	48	7	3	18	6	7
Lowell	74	32	115	37	111	52	58
Nepeuskum	43	23	55	13	56	25	16
Oconomowoc	19	63	24	15	34	14	17
West Bend	4	23	12	3	7	1	5
Woodville	10	13	12	2	12	4	6
Total	227		341	96	323	135	135

Coefficient of correlation (X and Y) = 0.93.
Standard error of estimates (Y – T) = 619 acres.
Probable error of estimate (619 times .6745) = 418 acres.

mates had clustered in some counties and under estimates in other counties, such a high value of the coefficient of correlation could not have resulted.

TABLE IX

RELATIONSHIP BETWEEN ESTIMATED WET PASTURE ACREAGES AND LAND ECONOMIC INVENTORY ACREAGES OF GRASS MARSH IN THIRTEEN COUNTIES

County	Grass marsh acreage (Land Economic Inventory)	Estimate of wet pasture acreage (Table VII)
	X	Y
Dodge	40,161	52,900
Door	1,157	7,000
Fond du Lac	23,927	31,900
Jefferson	33,025	42,100
Kenosha	10,855	14,600
Kewaunee	509	3,800
Manitowoc	3,397	9,300
Ozaukee	1,392	2,700
Racine	10,095	11,900
Sheboygan	5,360	10,100
Walworth	17,342	30,500
Washington	9,903	17,600
Waukesha	35,224	34,400

Coefficient of correlation (X and Y) = 0.97.

MARSH HAY

Information on wild hay acreages is available from the assessors' reports. If there is any wild hay harvested in eastern Wisconsin which is not marsh hay, field observation did not reveal it. It is therefore considered permissible to use "wild hay" acreages as reported by the assessors to indicate "marsh hay."

CROPLAND

Predictions regarding the amount and distribution of cropland rest upon the inverse relationship of this category of land use to the log of the percentages of farm land in trees (Table X). Of course, neither of these two ingredients of the landscape may be expected to cause the other; nevertheless they are closely related. In the southern part of the region, trees almost everywhere occupy only the swamps or steep slopes. Here marshes are the most important potential source of additional cropland. In the north, trees may still be found growing on well drained upland which is level enough for crops, and there is at present little reason for developing cropland through drainage.

TABLE X

DATA RELATED TO PERCENTAGES OF WET LAND IN CROPS IN THE TEN SAMPLE TOWNS

Sample town	Actual percent of wet land in crops, including wild hay	Percent of farm land in trees	Log of percent of farm land in trees	Estimated percent of wet land in crops, including wild hay
	Y		X	T
Aztalan	7.5	5.0	.70	9.1
Bailey's Harbor	0	29.6	1.47	0
Dunn	1.7	8.7	.94	5.6
Hartland	2.2	15.2	1.18	1.9
Linn	4.5	7.7	.89	6.3
Lowell	15.4	2.8	.45	12.7
Nepeuskum	10.1	3.7	.57	10.9
Oconomowoc	10.8	6.1	.79	7.7
West Bend	1.8	16.1	1.21	1.8
Woodville	6.0	7.9	.90	6.1

Coefficient of correlation (X and Y) $= -0.90$.
Estimates are made by the formula $T = -1.45X + 19.2$.
Standard error of estimate $(Y - T) = 2.17$ percent of all wet land.
Probable error of estimate (2.17 times .6745) $= 1.46$ percent of all wet land.

Some census data on artificial drainage of land[13] show a very close relationship to county estimates of wet cropland (Table XI). As Leslie Hewes has pointed out, one should be aware of the exact meanings of the column headings before drawing any conclusions from the figures.[14] In Wisconsin, where whole forty-acre

[13] The figures of the X column of Table XI were obtained by adding items 2 and 6 from Table II, pp. 455–458 of the *16th Census of the U. S.*, 1940, *Drainage of Agricultural Lands.*

[14] Leslie Hewes, "Drained Land in the United States in the Light of the Drainage Census," *The Professional Geographer*, Vol. 5, No. 6 (Nov., 1953), pp. 6–12.

tracts are usually included in drainage districts regardless of the amount of poorly drained land in each tract, the number of miles of drain is a preferred indicator of the amount drained. This is especially true in much of the southern half of eastern Wisconsin, where most of the subsoil is gravel and where most of the draining took place.

TABLE XI

RELATIONSHIP BETWEEN ESTIMATED WET LAND CROP ACREAGES AND MILES OF DRAINAGE DITCH AND TILE (U. S. CENSUS) IN ELEVEN COUNTIES

County	Miles of drain 1940	Estimated acreages of wet land in crops including wild hay (Table VII)
	X	Y
Dodge	279.8	14,140
Fond du Lac	41.6	6,350
Jefferson	197.9	7,670
Kenosha	41.9	1,400
Manitowoc	4.3	600
Ozaukee	26.8	180
Racine	120.8	190
Sheboygan	21.1	1,070
Walworth	46.1	2,510
Washington	16.1	1,550
Waukesha	39.7	3,660
Total	836.1	39,320

Coefficient of correlation (X and Y) = 0.83.

The value of 0.83 for the coefficient of correlation between miles of drain and estimates of wet cropland indicates that an added measure of confidence may be placed in these figures (Table VII). The placing of dots on the map showing wet cropland was accompanied by an element of subjective judgement, however, because fewer than thirty-five towns had more than 500 acres estimated in this use.

WASTELAND

Wasteland is so called because it has no agricultural use in the usually accepted sense of the word. On the whole it is the wettest of all marshes. In fact, if such land were only a little drier it would probably be used for pasture. The vegetation types which contribute to this category of land are:

1. Cattail, which always grows in places too wet for any agricultural use.
2. Sedge, which makes up most of the wasteland, but in places is used for pasture or marsh hay.
3. Brush, largely willow and tag alder, which is usually wasteland, but in places is used for pasture.
4. Miscellaneous minor types such as wild cranberry, leather leaf, and weedy peat.

The best way found to predict the amount and distribution of wasteland was to add the acreage estimates of all other uses and subtract that sum from the total

TABLE XII

ESTIMATED ACREAGES OF VARIOUS WET LAND USES AND ACTUAL ACREAGE OF WASTELAND IN THE TEN SAMPLE TOWNS

Sample town	Swamp	Open pasture	Crops including wild hay	Sums of I, II, and III	All wet land	Waste-land (V minus IV)	Actual waste-land acreage
	I	II	III	IV	V	VI	VII
Aztalan	220	510	140	870	1,570	700	91
Bailey's Harbor	5,390	220	0	5,610	6,420	810	458
Dunn	100	1,770	180	2,050	3,180	1,130	1,832
Linn	20	650	60	730	900	170	115
Hartland	3,650	750	90	4,490	4,430	-60	117
Lowell	840	5,180	1,350	7,370	10,660	3,290	2,730
Nepeuskum	520	2,500	550	3,570	5,000	1,430	2,085
Oconomowoc	480	1,430	190	2,100	2,460	360	602
West Bend	420	120	20	560	1,040	480	129
Woodville	940	360	90	1,390	1,540	150	159
Total	12,580	13,490	2,670	28,740	37,200	8,460	8,318

Coefficient of correlation (VI and VII) = 0.87.

Standard error of estimate, using VI as estimate of VII, is 515 acres. The probable error is 347 acres.

amount of wet land. The remainder was taken as the estimate of wasteland acreage. Pertinent information necessary to make wasteland estimates for the sample is gathered together from previous sections of this paper and listed in Table XII. This simple method of estimating the amount of wasteland yields encouraging results,

TABLE XIII

RELATIONSHIP BETWEEN ESTIMATED WASTELAND ACREAGES AND LAND ECONOMIC INVENTORY ACREAGES OF SELECTED TYPES OF LAND COVER IN THIRTEEN WHOLE COUNTIES

County	Estimated acreage of waste (Table VII)	Total acreage of selected land cover types, Land Economic Inventory*	Marsh hay acreage (Table VII)	X_1 minus marsh hay acreage
	Y	X_1		X_2
Dodge	45,510	77,257	7,240	70,017
Door	1,860	5,156	100	5,056
Fond du Lac	9,100	28,333	780	27,553
Jefferson	19,930	30,730	5,470	25,260
Kenosha	6,050	9,222	260	8,962
Kewaunee	290	2,963	0	2,963
Manitowoc	4,950	8,919	370	8,549
Ozaukee	1,220	6,101	130	5,971
Racine	3,460	4,159	10	4,149
Sheboygan	9,380	13,528	40	13,488
Walworth	8,840	17,815	300	17,515
Washington	3,850	14,517	450	14,067
Waukesha	12,990	10,584	360	10,224
Total	127,430	229,284	15,510	213,774

* Includes tag alder and willow, cattail, sedge marsh, weedy peat, and other minor open marsh types.

Coefficient of correlation (X_2 and Y) = 0.95.

as evidenced by the relatively low values of the probable and standard errors of estimate (484 and 326 acres, respectively).

In Table XIII the county estimates of wasteland for the thirteen whole counties of eastern Wisconsin are compared with Land Economic Inventory acreages of all types of vegetation cover which contribute to the wasteland total. The coefficient of correlation (0.95) indicates that the over and under estimates must have distributed themselves quite evenly throughout the region. In support of the map of wasteland (Fig. 3) it can be pointed out that some large and well-known marshes appear on it. Three such large areas of wasteland are Horicon Marsh in north central Dodge County, Sheboygan Marsh in northwest Sheboygan County, and marshes associated with the "Four Lakes" in Dane County. Readers having a knowledge of other specific large areas of unutilized marsh will most likely be able to locate them on the map.

SUMMARY

Total Wet Land. The predictions of total wet land are based on two surveys which took note of the amount and distribution of wet land. Information from these two sources was supplemented by knowledge gained during the mapping of nearly forty thousand acres in the field. The probable error of estimate of 619 acres per town should not cause undue concern, because the acreage which changes from marsh surface to open water and back again within a year's time may well exceed these limits in some towns.

Swamp. Indicated acreages of swamp are based on the Land Economic Inventory which took special note of all types of swamp.

Hay Marsh. The amount and distribution of hay marsh is available from the assessors' records.

Open Pasture, Cropland, and Wasteland. The methods used to make estimates of these uses are common to other sciences but are just coming into use in geographic research. An abundance of data made it possible to conduct an "independent audit" of these figures, the results of which were highly encouraging.

It is believed that the map showing distribution of land use (Fig. 3) is about as accurate as one which might have been made *at this scale* had the whole million acres of swamp and marsh been mapped in the field. The approach here demonstrated would seem to be applicable in many fields of geographic research. It is most needed in studies at the intermediate scale, or what Preston James would call the chorographic scale.[15] Good use is made of techniques developed by microgeographers, and along with this are demonstrated new uses for data already compiled by others.

[15] Preston E. James, "The Terminology of Regional Description," *Annals*, Association of American Geographers, XXIV (1934), pp. 79–92. Also: "Toward a Further Understanding of the Regional Concept," *Annals*, Association of American Geographers, XLII (1952), pp. 195–222.

GEOGRAPHIC REGIONS OF MISSOURI*

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THE State of Missouri is geographically diverse. Several systems of areal subdivision of Missouri have been developed, some complete for the entire state and some for major areas within the state, notably the Ozark region. Few of these have considered several or all of the component elements of the total pattern; most have been limited in scope and purpose. This paper attempts to synthesize the many and varying areal patterns into a system of regions, each of which is relatively homogeneous in its total complex and significantly different from adjacent regions.

PREVIOUS STUDIES

Large generalized topographic and physiographic regions in Missouri have long been recognized. Three of the major physiographic provinces of the United States[1] extend into the state—the Coastal Plain in the southeast, the Ozark Plateaus in the south, and the Central Lowland in the north and west.

One of the earliest attempts to divide the whole of Missouri into areal units was that of Marbut,[2] who mapped and described a series of plains and uplands separated by escarpments (Fig. 1). This system of areas is not adequate for geographic regionalization, but it does contribute to an understanding of the surface configuration of the state and to an acceptable pattern of areal units.

The earliest and most complete geographic analysis of any large part of the state was Sauer's study of the Ozark Highland.[3] Sauer conceived of the Ozark Highland as a single geographic unit, as indeed it is when the larger aspects of the country are considered. For a more detailed analysis of internal differences, however, he subdivided it into eight "provinces," consisting of (1) four regions in the Ozark Center: the Central Plateau, White River Hills, Osage-Gasconade River Hills, and Courtois Hills, (2) three border regions: the Springfield Plain, Missouri River Border, and Mississippi River Border; and (3) an intermediate region: the St. Francois Knob and Basin Region (Fig. 2).

* Much of the work on this paper was done under a University of Missouri Research Fellowship during the summer of 1952.

[1] N. M. Fenneman, "Physiographic Divisions of the United States," *Annals*, Association American Geographers, Vol. 18 (3rd ed., 1928), pp. 261–352, and *Physiography of Eastern United States* (McGraw-Hill, 1938).

[2] C. F. Marbut, "Physical Features of Missouri," *Missouri Geological Survey Report*, Vol. X (1896), pp. 11–109.

[3] Carl O. Sauer, *Geography of the Ozark Highland of Missouri*, The Geographic Society of Chicago, Bull. No. 7, 1920.

Schottenloher[4] also studied the Ozark area, including its extensions into Oklahoma, Arkansas, and Illinois. His regional divisions follow Sauer's and utilize Marbut's as well. Schottenloher divided the Ozark region of Missouri into (1) three central hilly regions (St. Francois-*Berggebiet,* Current River-*Hügelland,* and Osage River-*Hügelland*), (2) northern and eastern border zones (Missouri-

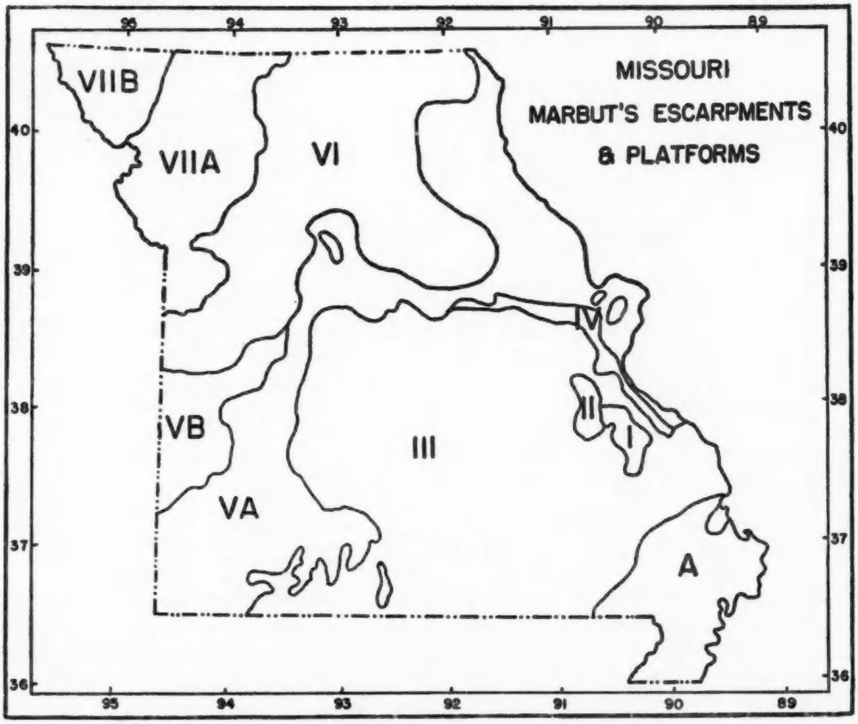

FIG. 1. Marbut's Escarpments and Platforms. The designated areas with separating escarpments are: I, Jonca Platform (Avon Escarpment); II, Summit Platform (Potosi Escarpment); III, Salem Platform (Burlington Escarpment); IV, Zell Platform (Crystal Escarpment); V, Barton Platform: VA, Springfield Structural Plain, VB, Nevada Lowland (Henrietta Escarpment); VI, Warrensburg Platform: VIA, Leeton Upland, VIB, Holden Lowland (Bethany Escarpment); VII, Gentry Platform: VIIA, Lathrop Upland, VIIB, Maryville Lowland; A, Tertiary Lowland.

Randlandschaft and Mississippi-*Randlandschaft*), (3) three central and western level uplands (*Zentralplateau,* Springfield-*Hochebene,* and Neosho-*Randgebiet*), and (4) the White River Hills, which wedge between the Central Plateau and Springfield Plain.

[4] Rudolf Schottenloher, "Das Ozarkland," in *Amerikanische Landschaft,* ed. by Erich von Drygalski (Berlin, 1936), pp. 1–128.

Cozzens[5] divided the Ozark province into natural regions, geologic regions, physiographic regions, and forest cover regions, his natural regions being a synthesis of all the others (Fig. 3). These natural regions do not differ markedly from Sauer's geographic provinces. The core areas are identical in most instances and differences are chiefly in boundary delineation.

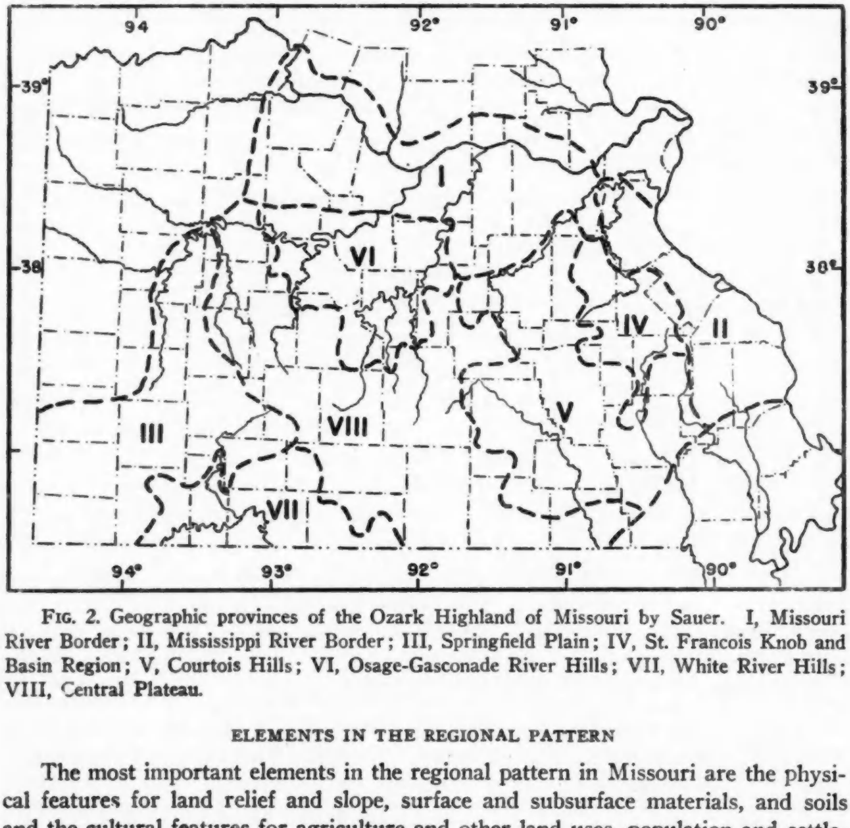

FIG. 2. Geographic provinces of the Ozark Highland of Missouri by Sauer. I, Missouri River Border; II, Mississippi River Border; III, Springfield Plain; IV, St. Francois Knob and Basin Region; V, Courtois Hills; VI, Osage-Gasconade River Hills; VII, White River Hills; VIII, Central Plateau.

ELEMENTS IN THE REGIONAL PATTERN

The most important elements in the regional pattern in Missouri are the physical features for land relief and slope, surface and subsurface materials, and soils and the cultural features for agriculture and other land uses, population and settlements, transportation and other forms of communication, sources of livelihood, levels of living, and social organization.

Topography. A basic factor in the regional differences within Missouri is topography. Not only is topography a significant factor in land capability and land use,

[5] Arthur B. Cozzens, "Analyzing and Mapping Natural Landscape Factors of the Ozark Province," *Transactions*, Academy of Science of St. Louis, Vol. 30 (1939), pp. 37–63. This is an abridgement of "Natural Regions of the Ozark Province," Ph. D. dissertation, Washington University, St. Louis, 1937.

but it is of direct consideration in the character and utility of soils, the amount and conditions of soil moisture and ground water, and in types of original native vegetation. Each of these has its own pattern of distribution, but all are related in some degree to the topography. Moreover, most of the cultural features are also related in some degree to topography and to other physical features.

The chief measurable components of topography are slope and local relief. The great bulk of the land in Missouri has moderate slopes of three to 10 percent

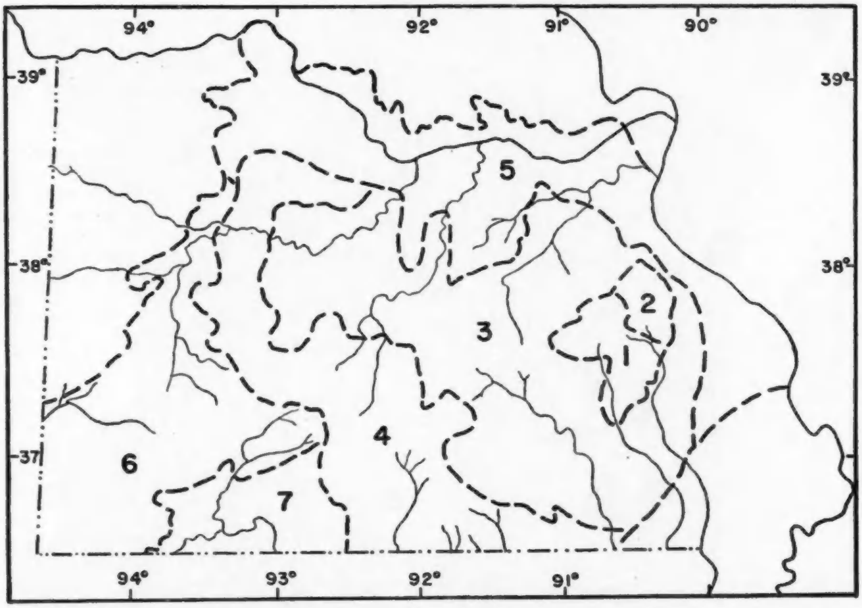

FIG. 3. Natural Regions of the Ozark Province by Cozzens. 1, St. Francis Forested Knob; 2, St. Francis-Big River Cleared Lowland; 3, Osage-Gasconade-Meramec Hills Forest; 4, Marshfield Forested Slope; 5, Cleared River Border; 6, Springfield Forest-Prairie; 7, White River Hills.

(Fig. 4). Areas with a prevailing slope of less than three percent are confined either to alluvial lowlands bordering the several large streams of the state, including the extensive plain of the Mississippi Embayment in southeastern Missouri, or to level upland remnants. The largest areas of the latter type of nearly level land occur in the northeastern part of the state, where tributaries of the Mississippi and lowermost Missouri rivers have eroded valleys into the upland but have not completely destroyed the original plain. Areas of level upland with less than three percent slope also occur in the central and southwestern parts of the state. All are along drainage divides and represent essentially unchanged remnants of the formerly more extensive surface.

All areas with slopes exceeding 10 percent are adjacent to major streams or in the area of igneous rocks. Areas of more than 20 percent slope are confined to river-bluff zones and the most rugged parts of the interior Ozarks, particularly the sides of granite and porphyry knobs in the outcrop area of igneous rocks.

The difference in elevation within local areas—local relief—is a partial measurement of length of slope and degree of ruggedness. It measures the height of hills

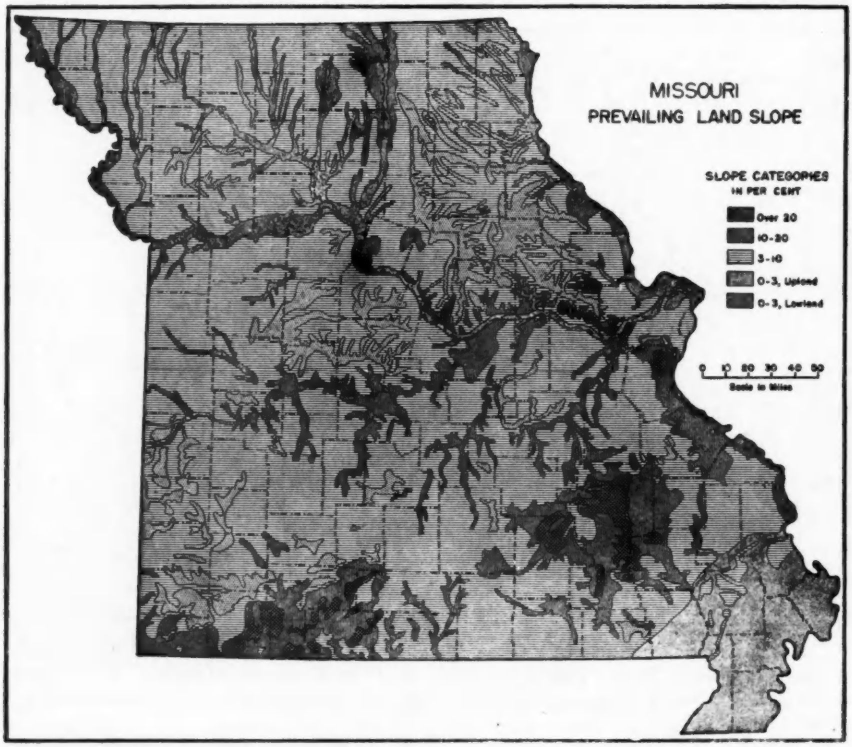

FIG. 4. Prevailing Land Slope, measured on U. S. Geological Survey topographic maps.

and ridges above the bottoms of nearby valleys and, in combination with angles of slope, is a measure of the configuration of the surface.

The local relief in Missouri varies from less than 100 feet on the alluvial lowlands and on a few remaining areas of undissected uplands to as much as 1,000 feet in the area of igneous knobs. Over much of the southeastern lowlands the actual relief is less than 10 feet, but no other area of comparable size is as flat. In most of the several individual areas of igneous rocks the local relief exceeds 750 feet (Fig. 5) and is the maximum of the state.

A second large area of high relief and steep slope is the White River Basin of southwestern Missouri. Here the depth of plateau dissection by the White River and its tributaries exceeds 500 feet. Slopes generally are greater than 10 percent and some exceed 20 percent.

These two areas having the maximum local relief of the state are bordered by zones of 400 to 500 feet relief. Only along parts of the Gasconade, Missouri, and Mississippi rivers does local relief exceed 400 feet anywhere else in the state. Except

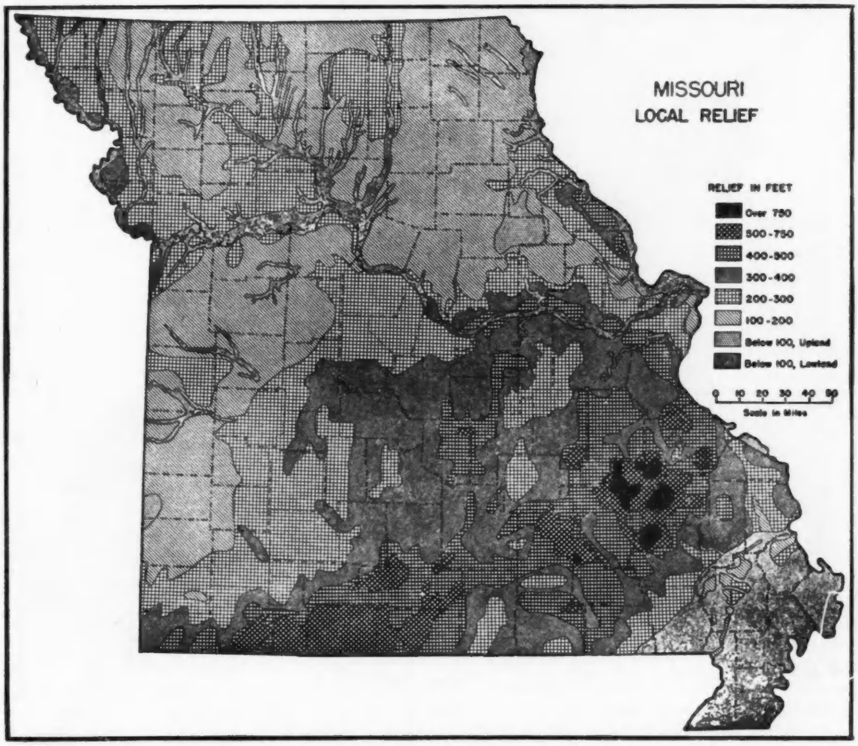

FIG. 5. Local Relief, determined within five-minute rectangles from U. S. Geological Survey topographic quadrangles.

in the vicinity of the larger streams, local relief in northern and western Missouri is less than 200 feet and in limited areas less than 100 feet. The dissected zones extending a few miles from the larger streams of north-central and northwestern Missouri have a relief between 200 and 300 feet, but slopes in these areas are not steep.

Soils. As a major element in the physical environment the soils of Missouri play a leading role in the patterns of regionalism. They have a distributional pat-

tern of their own, and soil characteristics reflect and tend to summarize other elements of regional differentiation, including topography, surface materials, climate, and natural vegetation. Their influence on land productivity and similar aspects of agriculture lead to other areal differences, including social and economic conditions.

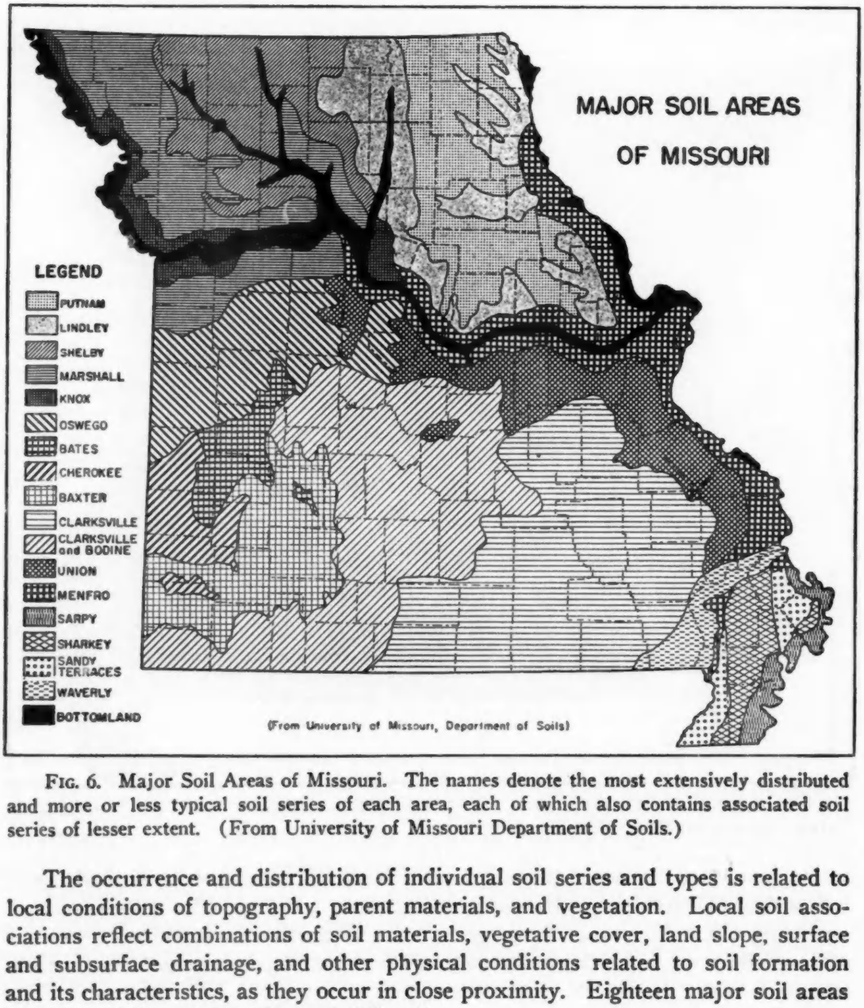

FIG. 6. Major Soil Areas of Missouri. The names denote the most extensively distributed and more or less typical soil series of each area, each of which also contains associated soil series of lesser extent. (From University of Missouri Department of Soils.)

The occurrence and distribution of individual soil series and types is related to local conditions of topography, parent materials, and vegetation. Local soil associations reflect combinations of soil materials, vegetative cover, land slope, surface and subsurface drainage, and other physical conditions related to soil formation and its characteristics, as they occur in close proximity. Eighteen major soil areas have been delineated in Missouri (Fig. 6).

Land Use. The use of land in Missouri is one of the most significant com-

ponents of the regional pattern. Land use exhibits a distinctive pattern of distribution and strongly reflects other factors of regionalism, particularly topography and soils. The major uses of land—for crops, pasture, and forests—are based ultimately on the character and productivity of the land and rather accurately reflect its quality.

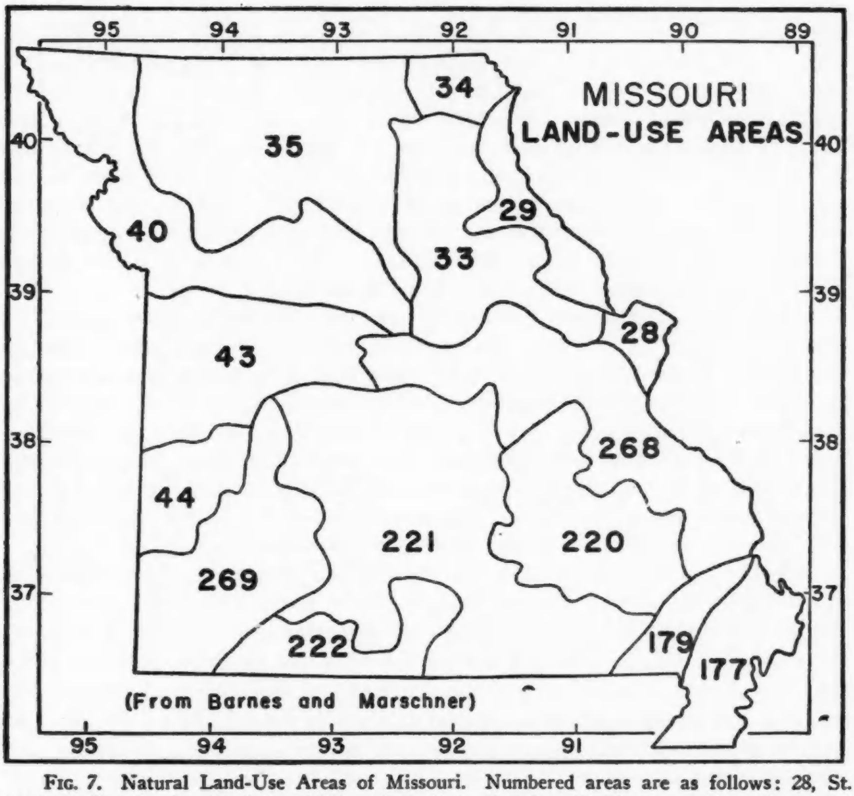

FIG. 7. Natural Land-Use Areas of Missouri. Numbered areas are as follows: 28, St. Louis Rolling Lands; 29, Quincy Hills; 33, Audrain Prairies; 34, Keosauqua Loess Flats and Hills; 35, Missouri-Iowa Loess Flats and Drift Hills; 40, Missouri Valley Loess Hills and Rolling Prairies; 43, Osage Prairies; 44, Northern Cherokee Prairies; 177, Mississippi River Bottoms (Northern Division); 179, Mississippi Silty Terraces and Low Ridges; 220, Ozark Center; 221, Middle Ozark Plateau; 222, Southwestern Ozark Plateau; 268, Northeastern Ozark Border; 269, Springfield Upland.

The land-use characteristics of Missouri have been delineated areally into 15 natural land-use areas[6] (Fig. 7). These are part of a system of 272 divisions of

[6] C. P. Barnes and F. J. Marschner, "Natural Land-Use Areas of the United States," map, 1:4,000,000, with marginal text (U. S. Dept. Agri., Bur. Agri. Econ., 1933). Additional text material supplied by F. J. Marschner, July, 1952.

the United States, based upon the physical characteristics of the land influencing its use. The 15 divisions which lie wholly or partly in Missouri constitute a type of regional subdivision of the state.

Eight areas (Fig. 7, areas 28, 29, 33, 34, 35, 40, 43, 44) in northern and western Missouri are classed as Midcontinent-type. These are agricultural areas of demonstrated agricultural quality, largely in farms and supporting relatively remunerative agriculture. In the western and northeastern Ozark border areas (268, 269, Fig. 7), lands of good agricultural quality and largely in farms predominate, but these are interspersed with lands of different physical character, the best use of which is open to question. The central Ozark areas (220, 221, 222, Fig. 7) have hilly or rolling lands, in large part steep, stony, or low in productivity. A large part is in forest. Subsistence agriculture prevails in the rougher and more remote portions. The southeastern lowland of Missouri (areas 177 and 179) is classed as smooth, inherently productive, but in large part poorly drained, a considerable part in forest, and part subject to inundation. The desirability of clearing and draining forested and undrained areas is questionable.

Socio-Economic Factors. Several economic and social factors enter significantly into the pattern of regionalism. In a sense, the use of land is one of these, although it is perhaps more closely related to the physical conditions of land than to economic or social conditions. Economic factors include sources of livelihood, levels of income, and types of farming. Social factors include planes of living, age characteristics of the inhabitants, birth and death rates, school attendance, levels of educational attainment, and other characteristics of the population. The physical and cultural characteristics of the area are inter-related and interdependent, and they form complex but generally similar patterns of distribution.

Livelihood Areas. Several of the regional economic factors have been summarized in a division of the state into livelihood areas[7] (Fig. 8). The system delineates 235 areas in the United States, 12 of which include portions of Missouri. No characterization of individual areas is provided, but the stated objective of the map is that each delineated area be characterized by a high degree of uniformity in its present economic development and in its resource potentialities. The areas are thus based upon natural resources and their utilization, and several are recognizably similar to land-use areas.

State Economic Areas. The state economic areas developed by the Bureau of the Census[8] are relatively homogeneous subdivisions, each having certain significant characteristics which distinguish it from adjoining areas. Criteria considered in the subdivision include demographic, climatic, physiographic, and cultural factors, as well as industrial and commercial activities. Division of each state into its prin-

[7] F. J. Marschner, "Livelihood Areas of the United States," map (1:7,500,000), in *Area Analysis—A Method of Public Works Planning,* National Resources Planning Board, Technical Paper No. 6, 1943 (revised).

[8] *State Economic Areas,* by Donald J. Bogue, p. 1. Procedures for delimiting the areas are outlined in pp. 3-6.

cipal units, within each of which a distinctive economy prevails, is implied. The term "economy" is used in a broad sense, referring to "the total adjustment which the population of an area has made to a particular combination of natural resources and other environmental factors."[9] Two categories of areas are recognized in the system, metropolitan and non-metropolitan. Two metropolitan and nine non-

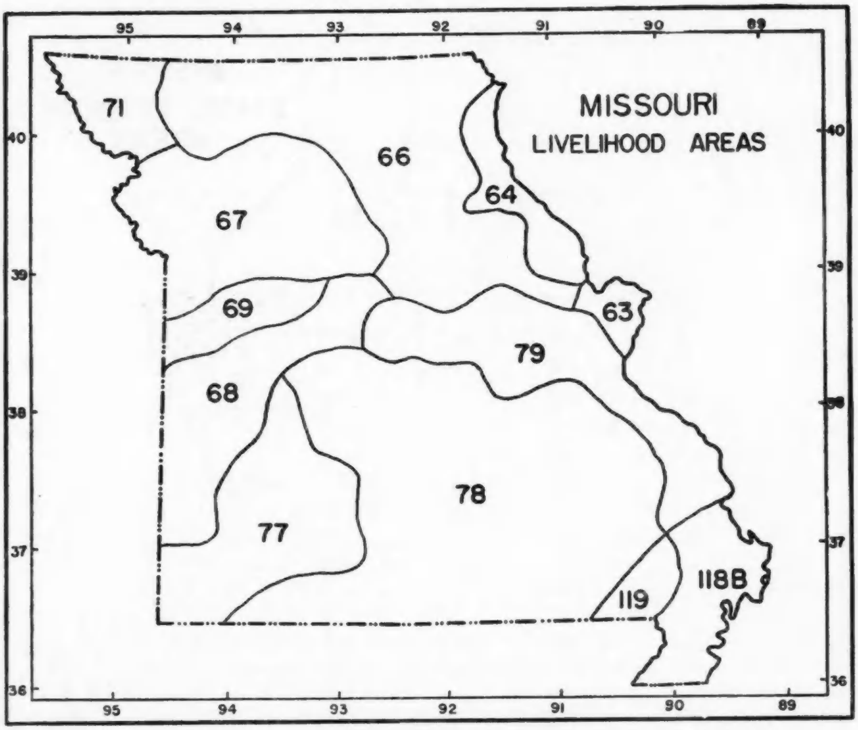

FIG. 8. Livelihood Areas. 63, St. Louis Environs; 64, Quincy-Peoria Area; 66, Southern Iowa-Northern Missouri Area; 67, Kansas City Environs; 68, Cherokee Area; 69, Osage Area; 71, Central Missouri Valley; 77 Springfield Upland; 78, Ozark Plateau; 79, Northeastern Ozark Border; 118b, Upper Delta, Missouri Section; 119, Mississippi Terrace Ridge Area. Areas 63 and 64 are subdivisions of the Eastern Corn Belt-Industrial group of livelihood areas; areas 66 through 71 of the Western Corn Belt group; areas 77, 78, and 79, of the Ozarks-Southern Appalachians group; and areas 118b and 119 of the Central Cotton-Forest group.

metropolitan areas are delineated in Missouri (Fig. 9). Several of the areas are almost identical to other divisions presented. Differences in details of boundaries result in part from the use of county boundaries.

Agricultural Regions. Missouri includes parts of three major agricultural

[9] *Loc. cit.*

regions: the Cotton Belt, the Corn Belt, and the Corn and Winter Wheat Belt.[10] Greater detail of differentiation of agricultural patterns is provided by a types-of-farming study.[11] In this the state is divided into seven major types-of-farming areas. Four of these have from two to six subdivisions; one has three non-contiguous parts (Fig. 10).

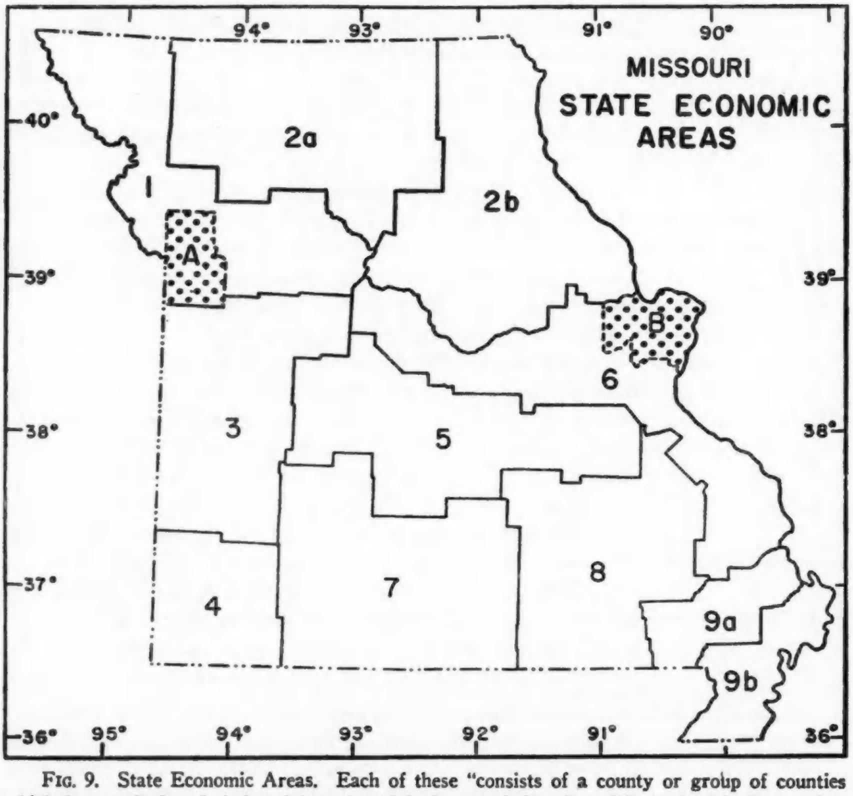

FIG. 9. State Economic Areas. Each of these "consists of a county or group of counties which has agricultural, industrial, and social characteristics that differentiate it from other adjoining areas." (From U. S. Bureau of the Census, 1950.)

Rural Social Areas. Rural social areas of Missouri have been delineated into six units,[12] in each of which there is a high degree of homogeneity with respect

[10] O. E. Baker, "Agricultural Regions of North America," *Economic Geography*, Vol. II (1926), pp. 459–493; Vol. III (1927), pp. 50–86, 309–339, 447–465.

[11] Conrad H. Hammar, Walter J. Roth, and O. R. Johnson, *Types of Farming in Missouri*, Missouri Agricultural Experiment Station, Bulletin 284 (1947).

[12] C. E. Lively and C. L. Gregory, *Rural Social Areas in Missouri*, Missouri Agricultural Experiment Station Research Bulletin 414, 1948.

to population, social organization, and culture. Four of the six major areas are subdivided, so that there are a total of 15 units (Fig. 11). The major divisions are relatively homogeneous areas with respect to a large number of factors; minor divisions based upon additional elements break the larger principal areas into

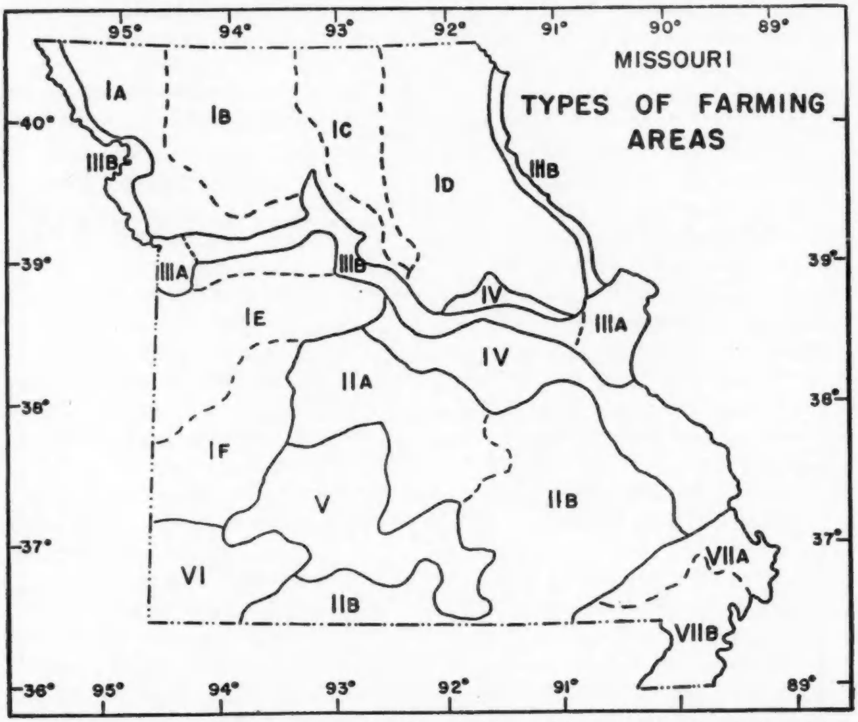

FIG. 10. Types of Farming Areas in Missouri (from Missouri Agricultural Experiment Station Bulletin 284, 1947). I, Northern and Western Meat Producing Area: IA, Marshall subarea, IB, Grundy-Shelby subarea, IC, Shelby-Lindley subarea, ID, Putnam-Lindley subarea, IE, Summit subarea, IF, Cherokee-Bates-Oswego subarea; II, Ozark Meat Production Area: IIA, Clarksville-Lebanon subarea, IIB, Clarksville-Huntington subarea; III, Cash Grain, Tuck and Fruit Area: IIIA, Suburban subarea, IIIB, River Bottoms and River Bluffs subarea; IV, Ozark Border Dairy and Wheat Area; V, Ozark Plateau Dairy and Poultry Area; VI, Southwest Fruit, Dairy and Poultry Area; VII, Southeast Lowland Cash Crops Area: VIIA, Northern Corn, Cotton and Wheat subarea, VIIB, Southern Cotton subarea.

smaller and still more homogeneous units. The areas were determined by analysis of county data, and boundaries follow county lines.

GEOGRAPHIC REGIONS

The conventional fourfold subdivision of Missouri has a sound basis and is doubtless adequate for many general studies. The four areas thus recognized—

Ozark Highland, Western Old Plains, Northern Glaciated Plains, and Southeastern Lowlands—are markedly different, yet each is homogeneous in its broader aspects. Variations in the several regional factors within each are generally less than these differences among the four divisions. When geographic patterns are examined in greater detail, however, homogeneity within each of these major divisions becomes less apparent and subdivision into smaller units with less internal variation is suggested.

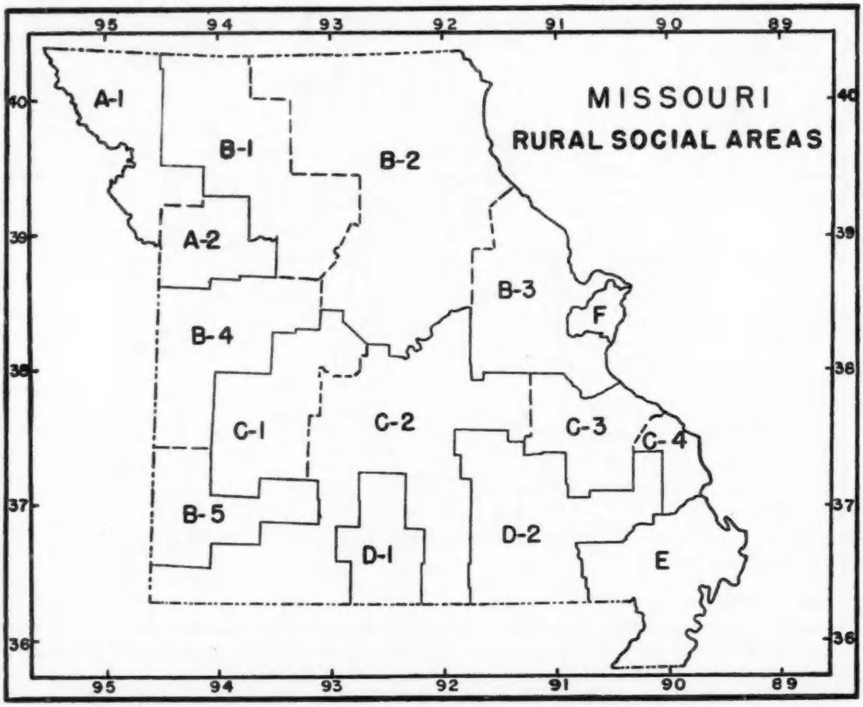

FIG. 11. Rural Social Areas of Missouri (from Missouri Agricultural Experiment Station Research Bulletin 414, 1948).

The size and number of possible areal units depends upon the number of regional factors considered and the amount of variation permitted within each unit. Most of the twenty divisions suggested here are subject to further subdivision if additional criteria are examined, or if those considered are held within narrower limits. The system of regions presented is believed to be adequate for most purposes, however, and an increase in the number would reduce the contrast among them. Combinations of physical and cultural features enter into the identity of each region, and the dominant factor or combination of factors of delineation varies from one to another. The characteristics of land and land use, both rural and urban, are

the most significant factors of regionalism employed. The land-use pattern and other aspects of human occupancy are closely related to the physical environment in most of the regions, but in the two urban regions physical habitat is less obvious and cultural structures dominate the landscape. Here too, however, human use of the area is the paramount criterion.

The four major divisions may be called "regions" and their subdivisions "subregions." Emphasis on the smaller units is believed to be preferable, however, and they should be termed "regions." The larger divisions composed of similar or related regions may well be called "provinces."

The four provinces differ markedly in topography, soils, land use, types of farming, planes of living, and other phenomena which exhibit patterns of regional distribution. Among them, contrasts between the Ozarks on the one hand and each of the plains areas on the other are greater than the differences among the plains provinces, particularly between the Northern and Western Plains. As compared with the Ozark province, the surface of each of the other provinces is smoother, its soils more productive, and its land better adapted to agriculture. Agriculture is more productive, incomes are higher, educational achievement is generally greater, and levels of living are higher than in the Ozarks. Both the Northern Plains and the Southeastern Lowlands are superior to the Western Plains in most of these respects. The Northern and Western Plains provinces have consistently declined in number of inhabitants during the past half-century, while the Ozarks and Southeastern Lowlands have increased. The increase in number of inhabitants is most marked in the Southeastern Lowlands and in all large urban centers.

The occurrence of glacial till and loess aids in broadly distinguishing the Northern Plains from the adjacent provinces. Most other characteristic features developed from this underlying factor. The dominantly alluvial material of the Southeastern Lowland Province, together with its southerly location and distinctive agriculture, form the chief basis for its differentiation from the upland provinces. In like manner, the dissected plateau of the Ozarks and old plains of the Western Plains, together with resulting features, are the major basis for distinguishing them.

The boundaries of the four provinces delineate their dominant features. Except for the two urban regions these lines serve also as regional boundaries. The southern boundary of the Northern Plains in the east is the approximate southern extent of glacial till. The southern boundary of the Northern Plains in the west is placed at the southern limits of deep loess (more than 8 feet). The loess thins rapidly southward from the Missouri River and is not topographically significant in the Western Plains.

The boundary of the Ozark Province is relatively distinct throughout its length. It is perhaps most obvious in the southeast, where the contrast between dissected upland and alluvial lowland is great. The least clear-cut line of demarcation is adjacent to the St. Louis Urban Region, where many Ozark features extend into the area of considerable urban influence.

The western boundary of the Ozark Province is less strongly marked than other portions. The Springfield Plain, the western-most subdivision of the province, is one of the superior regions of the state in its resource base and economic development, and it may be considered as transitional. Its wide upland divides are similar to Western Plains areas, but its stream borders, especially in the east, are like those of the adjacent Ozark Plateau. Over-all characteristics and local usage seem to place the Springfield Plain within the Ozark Province.

REGIONS OF THE NORTHERN PLAINS

Northwestern Loess Hills. The westernmost subdivision of the Northern Plains Province, the Northwestern Loess Hills, consists of the areas of deepest loess soils. The upland is rolling, particularly along the "breaks" of the Missouri River, but the deep, porous loess soils tend to reduce the effects of steep slopes. The region is the best agricultural area of the state, with the highest values of land and over-all productivity. Its land is its chief natural resource and its economy almost entirely agricultural.

The Northwestern Loess Hills is formed by that portion of the Missouri Valley Loess Hills and Rolling Prairies land-use area lying in Missouri north of Kansas City (Fig. 7). It is that part of state economic area 1 lying north of the Kansas City Urban Region (Fig. 9). The region includes most of the Marshall subarea of the Northern and Western Meat Production area, together with the adjacent river bottoms and river bluffs subarea of the Cash Grain, Truck, and Fruit type-of-farming area (Fig. 10). It corresponds with subarea 1 of the rural social areas (Fig. 11). The outstanding characteristic of the region is its high agricultural productivity and the resulting economic and social conditions.

Grand River Loess Flats and Drift Hills. The Grand River Loess Flats and Drift Hills region is approximately the Grand River basin. Grand River and its tributaries have cut broad valleys with wide flood plains into the till plain. Glacial till on which the dominant Shelby soils developed underlies most of the rolling land. Valley sides are not steep and slopes are generally under 10 percent. The upland plain remnants and valley floors have less than 3 percent slope (Fig. 4). Except for these loess flats and valley floors, however, the land is everywhere moderately rolling. Fifty to 60 percent of the area is cropland and most of the remainder is pastured. The region originally supported a prairie grassland except in the forested valleys. Woodland areas are limited to the rougher lands along the valley sides.

This region is the western three-fourths of state economic area 2a and of the Missouri-Iowa Loess Flats and Drift Hills land-use area (Figs. 9 and 7). It is approximately coincident with the Grundy-Shelby subarea of the Northern and Western Meat Production type-of-farming area (Fig. 10). It includes most of rural social subarea B-1 (Fig. 11), a subdivision based largely upon slightly greater farm tenancy than adjacent areas. Land and agricultural values in the region are well above the state average and three to four times those of the central Ozarks,

but below those of the Northwestern Loess Hills region. With the extensive areas of valley cropland, farm income from crops is proportionally greater than in the other livestock farming areas.

West Central Loess Hills. The West-Central Loess Hills border the Missouri River between the Kansas City Urban Region and the Northern Ozark Border Region. It consists of the flood plain and the rolling, loess-covered hills extending five to 25 miles from the river on each side. The chief boundary criterion on both north and south is the extent of Marshall and Knox soils, whose distribution corresponds to the deepest and most complete coverage of loess. The hills are rounded and rise from 200 to 300 feet above the flood plain, but average slopes are generally under 10 percent. There is little level land except on the flood plain.

This region is that part of state economic area 1 east of the Kansas City metropolitan area (Fig. 9). It is the southeastern segment of the Missouri Valley Loess Hills and Rolling Prairie land-use area (Fig. 7). It is separated from the northwestern portion of that area largely because of the intervening position of the Kansas City Urban Region, but also because of its minerals and mining activity. Limestone and shale are quarried in the region, and coal is mined in the western part.

Agriculture is the most important activity of the region and the major source of income. More than 60 percent of the land area is devoted to the production of crops. Land values and values of crops and livestock are almost as high as in the Northwest Loess Hills region. The region includes part of the Cash Grain, Truck, and Fruit Crops type-of-farming region, together with the adjoining margins of the Northern and Western Meat Production area (Fig. 10).

Chariton Hills. The Chariton River and its tributaries have developed an area of closely spaced, steep-sided, forested hills, which contrast sharply with the rolling prairies of the Grand River Hills to the west and the tabular uplands of the Audrain Prairies on the east. The characteristic topography extends southward beyond the Chariton River basin to the northern border of the Ozark Province, but the name Chariton Hills is here applied to the entire hilly region. Most of the loess mantle of the region has been removed; the glacial till has become exposed and intricately dissected. Land slopes of 10 to 20 percent prevail, although local relief is no greater than in the Grand River basin. Lindley soils dominate the region, and much of their area is unsuited for cultivation because of steep slopes.

The region is approximately coextensive with the Shelby-Lindley type-of-farming area, and it is the eastern portion of the Missouri-Iowa Loess Flats and Drift Hills land-use area. Because of the hilly topography, crop land is limited and inferior to that of adjoining regions, and farm land and agricultural values are lower. One-half or more of the farm land is pastured, and 80 to 90 percent of farm incomes are derived from the sale of livestock and livestock products. The region has few resources other than its agricultural land and its people.

Audrain Prairies. The area of wide, nearly flat, tabular remnants of the upland plain lying along the Mississippi-Missouri-Chariton drainage divide forms the

Audrain Prairies Region. The distinguishing boundary criterion is depth of valleys and steepness of their sides, both of which increase toward the Missouri and Mississippi rivers. The change in character of the land and its uses is abrupt on the west, and the western boundary is quite distinct.

The Audrain Prairies Region is characterized by Putnam and Mexico soils on nearly level terrain. Extensive areas have slopes of less than 3 percent and none exceed 6 or 7 percent. Local relief is less than 100 feet over most of the area. The region is essentially the same as the Audrain Prairies land-use area (Fig. 7), from which its name is taken. It falls within State Economic Area 2b (Fig. 9) and the Putnam-Lindley type-of-farming subarea, but is less inclusive than either.

The economy of the region is largely agricultural, but includes coal mining, clay production, and a limited amount of manufacturing. The region includes the northeastern Missouri fire clay district and contains refractory brick manufacturing plants. The agricultural emphasis is on livestock production, and pasture land is extensive. The proportional contribution of crops to the total value of farm products, however, is greater than in the previously discussed livestock-farming regions to the west, at least in part because of the extent of well-adapted, level land.

Mississippi River Hills. The Mississippi River border of the northern Missouri glacial plain varies from gently rolling to hilly. Most of the area consists of rolling hills with slopes between 3 and 10 percent. The relief of the river border zone exceeds 200 feet and reaches a maximum of 520 feet in one area. Local relief of 200 to 300 feet prevails, decreasing westward to approximately 100 feet at the eastern boundary of the Audrain Prairies. Alluvial land along the Mississippi is limited. Relatively wide bands of alluvium extend up tributary stream valleys, however, almost to the western boundary of the region.

This region is approximately the same as the Missouri portion of the Quincy Hills land-use area (Fig. 7), which extends across the Mississippi River into Illinois. The region also corresponds to the Quincy-Peoria livelihood area (Fig. 8). It includes the eastern margin of the Putnam-Lindley type-of-farming subarea (the Lindley portion), together with the adjacent Cash Grain, Truck, and Fruit area of the Mississippi flood-plain and hilly border—the area of Menfro soils.

Wyaconda Hills. Lying in the northeastern corner of the state, the Wyaconda Hills region shares the qualities of the adjacent regions. Level lands having dark prairie soils occupy elongated, tabular divides similar to those of the Audrain Prairies. The southeastward trending valleys have relatively wide, level floors. Between the two types of level lands are steep hillsides with light-colored forest soils similar to those of the Chariton River Hills and Mississippi River Hills. The land-use pattern of the region consists of linear bands of cropland and pasture in the valleys and on the upland plain, separated by bands of pasture and woodland, with limited cropland on the hillsides.

The Wyaconda Hills Region is nearly identical in its delineation to the Keosauqua Loess Flats and Hills land-use area (Fig. 7). Its soils are its chief resource and farming its dominant activity.

URBAN REGIONS

The St. Louis and Kansas City Urban regions are distinguished by the extent and intensity of urban forms and influences. Other urban centers are distributed over the state, but the areas of significant influence are too small for recognition as separate regions in the present system.

The boundaries of the urban regions enclose urban and suburban forms and functional areas, but no attempt is made to encompass the full urban influence, such as all of the surrounding zones of dairying, truck farming, and other agricultural specialties related to the urban markets. The nature and density of the settlement pattern, traffic flow and commuting, urban-oriented recreational facilities, and similar phenomena were considered in drawing the boundary lines, an attempt being made to include such features of the rural-urban fringe within the urban regions.

The two urban regions are more inclusive than the respective urbanized areas as delineated in the 1950 *Census of Population*, but they are smaller and more exactly delineated than the standard metropolitan areas and metropolitan economic areas, which include entire counties (Fig. 9). The regions approximate the two suburban subareas of the Cash Grain, Truck, and Fruit type-of-farming area (Fig. 10).

REGIONS OF THE WESTERN PLAINS PROVINCE

The intermediate position of the Western Plains in the range of conditions contrasting the Ozark Province and the Northern Plains is one of its identifying characteristics. Much of its area is actually smoother than that of the Northern Plains. Its soils are generally of lower quality than the glacial and loessial soils of the latter but superior to those of the Ozarks. Its agricultural productivity, planes of living, and other conditions are similarly intermediate in quality or level. A twofold subdivision of the province can be made.

Osage Plains. The Osage Plains Region is the northern subdivision of the Western Plains Province. It is an area of limestone, sandstone, and shale strata, differential erosion of which has produced a more rolling surface than the predominantly shale area of the Cherokee Plains subdivision on the south. The region has been called the Scarped Plains[13] and also the Osage Cuestas.[14] The Osage Section of the Central Lowland physiographic province of Fenneman[15] includes both subdivisions of the Western Plains Province. The Osage Plains Region is essentially the Oswego soil area (Fig. 6), the Osage Prairies land-use area (Fig. 7), and the Summit subarea of the Northern and Western Meat Production type-of-farming area (Fig. 10).

Agriculture is the major economic activity of the Osage Plains. More than one-third of the employed population is thus engaged, and more than one-half of

[13] Henry Hinds and F. C. Greene, *The Stratigraphy of the Pennsylvania Series in Missouri*, Missouri Bureau of Geology and Mines, 2nd ser. XIII (1915), p. 4.

[14] W. H. Schoewe, "Geography of Kansas, Part II, Physical Geography," *Transactions*, Kansas Academy of Science, LII (1949), p. 282.

[15] N. M. Fenneman, *Physiography of Eastern United States*, p. 605.

the area is cropland. Much of the remainder is pastured. Cultivated land is most extensive on the prairie divides and on the valley floors. Woodlands are confined largely to the valley sides. The agriculture of the region emphasizes livestock production, and more than three-fourths of the farm income is derived from the sale of livestock and livestock products.

Coal is the only important mineral resource of the region. It is mined in the southern part, primarily in Bates County. Stripping methods are used, and the coal seams are too deeply covered for economical mining except along the southern edge of the region. Mining is far more important in the Cherokee Plains Region, where the overburden is thinner.

Cherokee Plains. The southern part of the Western Plains province is a topographically old plain developed on relatively unresistant shales. The surface is gently undulating except for a few erosional remnants along the edge adjacent to the Osage Plains region. Most of the prairie interfluves have slopes of less than 3 percent and no areas exceed 10 percent. Local relief is nowhere greater than 200 feet and on the wider divides is under 100 feet. The valleys are wide, shallow, and flat-bottomed.

The Cherokee Plains region is identical to Marbut's Nevada Lowland (Fig. 1) and virtually identical to the Northern Cherokee Prairies land-use area (Fig. 7). It is characterized as level to gently rolling, with dark gray or dark brown silty soils having compact subsoils, and loams and sandy loams with friable subsoils. The region corresponds to the Cherokee-Bates-Oswego subarea of the Western Meat Production type-of-farming area.

The economy of the region is dominantly agricultural, emphasizing livestock production. More than one-half the total area is cropland and about one-third is pastured. Land values are lower than in the Northern Plains regions, but well above those of the Ozark regions. Coal mining is important, even though less than five percent of the employed inhabitants are engaged in mining. The coal seams are shallow and more accessible for strip mining than in other regions of the state.

REGIONS OF THE OZARK PROVINCE

The dissected plateau character of the Ozark Province as a whole is the key to its individuality and regional identity. It is unique among the several parts of the state in its extensive areas of rough, hilly land, its cherty soils, its limited areas of good agricultural land, its consequently lower agricultural productivity, and its extensive forest land. The degree of dissection and related characteristics are the chief basis of regional subdivision.

Springfield Plain. The Springfield Plain is the western Ozark border region. The surface of the region is smooth except near the larger streams which are bordered by belts of hilly land separating broad, nearly level upland plains. Productive silty soils occupy the smooth prairie uplands, while the hilly zones have lighter colored, less productive silt loams or gravelly loams.

The region was recognized by both Sauer and Cozzens (Figs. 2 and 3), although

both included the hilly land in Barton County to the south, which is here placed within the White River Hills region. Because of its ruggedness most of this area is forested, with little or no cropland except in the narrow valleys. The present division agrees with these several systems in the core area of the region, and differs only in delineation of the boundary. The Springfield Plain includes part of the Ozark Plateau Dairy and Poultry type-of-farming area, and all of the Southwest Fruit, Dairy, and Poultry area except the hilly section in the south. It includes rural social subarea B-5, the southwest border recognized chiefly because of its lead and zinc mining and the urban influence of Joplin and Springfield, and much of subarea C-1, the less hilly western portion of area C.

The mineral resources and mining activity of the Springfield Plain are significant. The southwestern part of the region lies within the Tri-State mining area, whose production of lead and zinc have long been important. Tripoli is another mineral resource of significance, and Carthage "marble" from the region is a widely used building stone.

White River Hills. The maturely dissected basin of the White River in Missouri is one of the most rugged divisions of the state. Only the St. Francois Knobs area and the Courtois Hills Region exceed it in land relief and slope. In most parts of the region more than one-half the area is in slopes exceeding 14 percent and three-fourths or more of the area is in slopes steeper than 5 percent. The average ridge is from one and one-half to two miles wide and 500 to 700 feet high.

Most of the White River Hills Region is forested. Cropland is confined largely to valley floors, narrow ridge tops, or occasional bench lands.

The resources of the White River Hills region are limited. Its economy is dominantly agricultural, in spite of the very limited amount of good agricultural land. Little income is derived from its forests and few of its inhabitants are employed in forest industries. Scenic and recreational resources are considerable and well developed. Hydroelectric energy is supplied by dams on the White River, and the associated reservoirs contribute materially to recreational activities.

The region is recognized by both Sauer and Cozzens (Figs. 2 and 3), with little difference in boundaries except in the west as previously noted. It is approximately coextensive with the Southwestern Ozark Plateau land-use area (Fig. 7), and with the southwestern portion of the Clarksville-Huntington subarea of the Ozark Meat Production type-of-farming area (Fig. 10). Since the relatively undissected and agriculturally productive Springfield Plain adjoins the region on the northwest and the Central Plateau separates it from other deeply dissected sections of the Ozarks, there is little or no question of the regional identity of the White River Hills. It extends into Arkansas on the south and forms one of the recognized regional divisions of the Ozark Province.

Central Plateau. The comparatively undissected plateau remnant lying across the major drainage divide of the Ozark Province forms the Central Plateau Region. Bordered on most sides by hill regions, the Central Plateau forms the largest and best preserved peneplain remnant of the province.

The Central Ozark Plateau is characteristically low in land relief and slopes are moderate. It is a dominantly agricultural region. Approximately one-half of its employed population are engaged in agriculture. From one-half to three-fourths of its land is in farms, but from one-half to three-fourths of the land in farms is forested. The emphasis is upon livestock production. The region lies within the Ozark Meat Production type-of-farming area. More than 90 percent of the farm income is derived from the sale of livestock and livestock products. Emphasis is given to dairying in the central and northwestern parts of the region.

The resources of the region provide little other than agricultural land. There are few minerals. The forests of the region are less valuable than those of the hilly regions. Manufacturing is little developed. The relative isolation of the region by the adjoining hilly areas has been a handicap to its development.

Osage-Gasconade Hills. North of the Central Ozark Plateau Region, the original peneplain surface has been thoroughly dissected and now forms a maze of hills among closely spaced dendritic valleys. The deepest and most intricately dissected areas border the larger streams, particularly the Osage and Gasconade and especially the latter. The hills rise 300 to 400 feet above valley floors over much of the area, and they exceed 400 feet along most of the length of the Gasconade River. Prevailing slopes exceed 10 percent in zones bordering the larger streams, but elsewhere in the region they are generally between 3 and 10 percent (Fig. 4).

The Osage-Gasconade Hills region is dominated by stony Clarksville soils. Forests are extensive, occupying practically all hillsides and covering all but the widest ridge tops. In the most rugged areas, only the valley bottoms have cropland of any value. The region of Osage-Gasconade Hills is chiefly agricultural from an occupational point of view. Almost one-half of its employed inhabitants are engaged in farming. About 10 percent are engaged in manufacturing, chiefly of forest or agricultural products.

The region was originally delineated and named by Sauer. Cozzens combined it with the Courtois Hills. The core of the region is recognizable in the state economic areas and types-of-farming areas. It is combined with other hilly areas in other systems.

Northern Ozark Border Region. The northern border region of the Ozark Province is transitional between the rugged hill regions of that province and divisions of the Northern Plains Province on the north.[16] It is intermediate between the two provinces in topography, quality of soils, productivity of agriculture, and several other respects.

The topography of the Northern Ozark Border Region is less rugged, soils are generally superior, and agricultural productivity is higher than in the Osage-Gasconade Hills and the Courtois Hills regions adjoining it on the south. The regions

[16] For a more detailed discussion of this region see James E. Collier, "Geography of the Northern Ozark Border Region in Missouri," *University of Missouri Studies*, Vol. XXVI, No. 1. (1953).

of the Northern Plains Province on the north are, on the whole, better in these respects.

The Northern Ozark Border Region is recognized by Sauer. It is combined with the eastern Ozark border, with which it has several features in common, in Cozzens' natural regions, and in the land-use, livelihood, types-of-farming, and state economic areas.

Courtois Hills Region. The irregularly-shaped Courtois Hills Region sprawls across the major Ozark divide and extends well down both north and south slopes of the dome. It is the most hilly subdivision of the Ozark Province and, as a whole, the most rugged area of Missouri. Deeply and minutely dissected by the Meramec and Big rivers in the north and by the Black and Current rivers in the south, the region is a maze of narrow, steep-sided, chert-covered ridges, monotonous in their similarity and most of them forested, chiefly with oaks.

More than three-fourths of the Courtois Hills Region is forested. Forest trees on the narrow ridge tops and steep hillsides are small. Those of the better watered valleys are larger, but limited in number. Forestry is thus handicapped and is contributing less than its potential to the economy of the region.

Except along the major drainage divide in the central part, the population of this region is confined chiefly to the valleys. Only on the narrow strips of moderately good farmland in the valleys and on occasional ridge tops have the forests been removed and the land converted to farmland. Farming is not highly developed and living conditions are poor. Many farms are self-sufficing. Corn is the principal crop. Cattle and hogs grazed on hillside pasture, much of it woodland pasture, are the chief livestock and source of cash income.

The Courtois Hills Region was originally defined by Sauer (Fig. 2). In the system of regions outlined by Cozzens it is included within the Osage-Gasconade-Meramec Hills Forest Region (Fig. 3). The region is essentially the Ozark Center land-use area (Fig. 7).

St. Francois Knob and Basin Region. The St. Francois Knob and Basin Region is unique among the hilly regions of the Ozark Province in the origin and character of the hills. Most of the hills are formed of granite or porphyry rocks which have been etched into relief because of their greater resistance to erosion than the sedimentary rocks. The latter form basins among the knobs. The knobs rise as much as 1,000 feet above the basin floors, although most are around 750 feet high (Fig. 5) and some are low and only a few tens of feet in diameter. The floors of the basin lowlands are gently to moderately rolling. They contain prosperous agricultural communities, more or less surrounded by a wilderness of knobs and ridges.

Physiographically the St. Francois Knob and Basin Region is at the center of the Ozark Province. Geographically it may be considered a border region because of its nearness to the Mississippi River and the eastern edge of the province.

The St. Francois Knob and Basin Region is the most important mining region of the state, and among the least important in agriculture, as measured by occupa-

tional employment. Mineral resources are extensive and varied, including lead, iron, barite, granite, and others.

Because of its unique geologic and physiographic characteristics and the resulting cultural features, the St. Francois Knob and Basin Region is recognized in practically all systematic divisions of the state. It has been given full regional status in most instances.

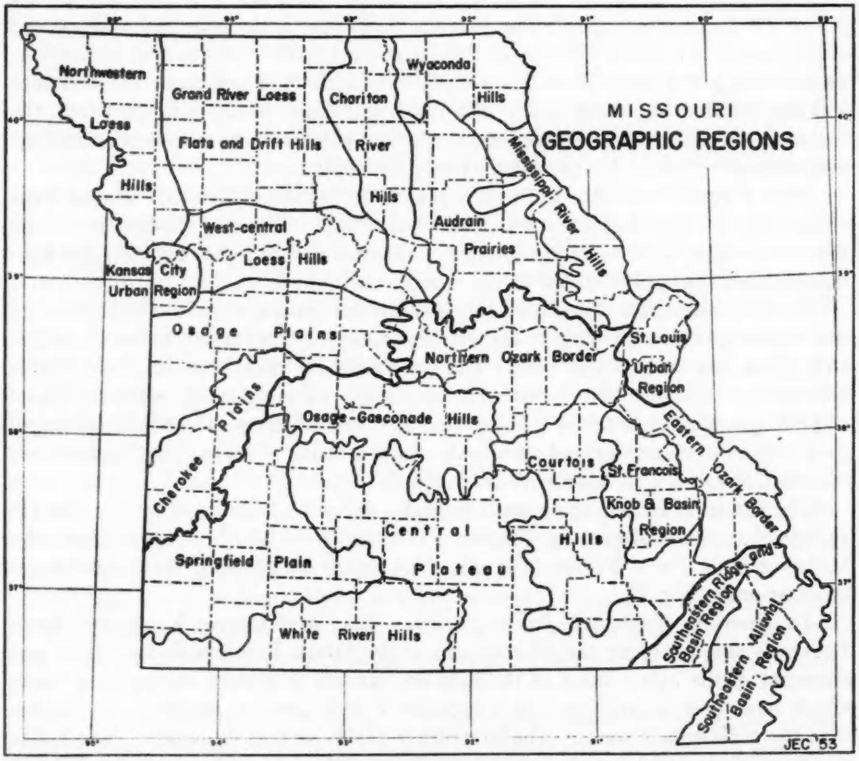

FIG. 12. Geographic Regions of Missouri, based upon a composite of physical and cultural features.

Eastern Ozark Border Region. The Eastern Ozark Border Region extends between the St. Francois Knob and Basin Region and the Mississippi River from the St. Louis Urban Region and the Northern Ozark Border Region to the Southeastern Lowland Province (Fig. 12). The accessibility of this Mississippi River border from the earliest period of settlement to the present has been one of its outstanding characteristics.

The Eastern Ozark Border Region is the lowest in elevation of the Province.

Its rocks are less cherty and its topography less rough than most subdivisions. Superior soils have developed on the loess which smooths the outlines of the hills along the Mississippi River. Southward the region broadens into a rolling limestone plain with karst features.

The resources of the Eastern Ozark Border Region are largely agricultural. Its minerals are limited to quarry products, chiefly clay and silica sand, and its forests have been extensively cleared to permit cultivation of the land.

The Eastern Ozark Border Region was initially recognized and given regional status by Sauer (Fig. 2). Cozzens combined it with the Northern Ozark Border as the "Cleared River Border" (Fig. 3). These two are similarly combined as the Northeastern Ozark Border land-use area (Fig. 7) and the Ozark Border Dairy and Wheat type-of-farming area (Fig. 10). The combined regions correspond to recognized livelihood and state economic areas (Figs. 8 and 9).

REGIONS OF THE SOUTHEASTERN LOWLANDS

The Mississippi River lowland in the southeastern "boot heel" of Missouri is unquestionably a logical regional division of the state. It contrasts strongly with other areas, particularly with the adjacent Ozark upland, which rises abruptly above it on the northwest in an escarpment 100 to 250 feet high.

The Southeastern Lowland consists of an alluvial plain divided by isolated hills and ridges into a series of poorly drained basins. It is distinct among the areal divisions of Missouri socio-economically and culturally as well as physically. Agriculturally the region emphasizes the production of cash crops, particularly cotton, and in recent years soybeans. Except for minor areas in nearby portions of the Ozark Province, cotton culture is limited to this part of the state. Nearly three-fourths of the total area of the Province is cropland and less than one-fifth is pasture.

Culturally the Southeastern Lowlands Province of Missouri is more like the South than the Midwest. Its agriculture has much in common with the South, and it is the only section of the state in which Negroes occur in significant numbers in the rural population.

Most of the hills and ridges of the Lowland are in the northwest. On the basis of the resulting soils, land-use, agricultural conditions, and other characteristics, the province can logically be subdivided into a Southeastern Ridge and Basin Region in the northwest and a Southeastern Alluvial Basin Region in the southeast (Fig. 12). This twofold subdvision is made, with minor differences in boundary, in the land-use areas, livelihood areas, state economic areas, and types-of-farming areas (Figs. 7, 8, 9, and 10).

Southeastern Ridge and Basin Region. The highest and most conspicuous ridges of the Lowland Province are contained in the Southeastern Ridge and Basin Region, together with their associated basins. The region consists of areas of recent alluvium, "second-bottom" terraces, and low ridges. The surface is predominantly level to undulating, although some of the loessial ridges are rolling

The soils range from leached and poorly drained clays on the first-bottoms to well drained, fine sandy loams on the terraces, and productive but easily eroded brown silt loams on the ridges. Cotton, corn, and wheat are the principal crops, with recently expanded acreages devoted to soybeans.

The region correlates with the Mississippi Silty Terraces and Low Ridges land-use area, the Mississippi Terrace Ridge livelihood area, state economic area 9a (unnamed), and the Northern Corn, Cotton, and Wheat subarea of the Southeast Lowlands Cash Crops type-of-farming area.

Southeastern Alluvial Basin Region. The broad alluvial lowland of the Mississippi River is called the Southeastern Alluvial Basin Region. The only ridges of significance in this southeastern subdivision of the Lowland Province are two low "sand" ridges, which rise only 10 to 20 feet above the adjacent basins. The surface of the region is nearly level and naturally poorly drained. Some of the low-lying lands are subject to overflow. Most of the area has been drained artificially and is devoted to crop production. Cotton is the dominant crop, with recently increasing acreages devoted to soybeans. Approximately three-fourths of the farms are operated by tenants.

The region is the equivalent of the Mississippi River Bottoms land-use area, the Upper Delta, Missouri Section, livelihood area, state economic area 9b, and the Southern Cotton subarea of the Southeast Lowlands Cash Crops type-of-farming area. It is the least typical of Missouri and the Midwest of all parts of the State.

THE CLIMATE OF CHINA ACCORDING TO THE NEW THORNTHWAITE CLASSIFICATION

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IN this paper climatic maps of China proper and Manchuria according to the Thornthwaite 1948 classification[1] are presented and discussed. The maps were prepared originally on a scale of 1 to 5 million under the direction of Dr. C. W. Thornthwaite at the Laboratory of Climatology, The Johns Hopkins University. Altogether, data of 285 climatic stations were used (Fig. 1).

Thornthwaite recognized that the moisture condition of a place cannot be determined by measuring the precipitation alone; that it must be gauged by comparing the precipitation with the potential evapotranspiration. He also derived an empirical formula for computing the potential evapotranspiration as a function of temperature and latitude. Out of this idea and kindred ones Thornthwaite developed a climatic classification. The procedures of computing the potential evapotranspiration and the details of his classification will not be discussed here, since the reader may refer to his original paper.

In presenting the climatic conditions Thornthwaite forsakes the attempt to depict them on one map. Instead he gives four maps: annual potential evapotranspiration, moisture index, seasonal variation of effective moisture, and summer concentration of thermal efficiency.

POTENTIAL EVAPOTRANSPIRATION

Since at O° C. there is no evapotranspiration[2] and above O° C. the relationship between the potential evapotranspiration and the temperature is an exponential one, it follows that the magnitude of the annual potential evapotranspiration of a place is influenced more by summer than by winter temperature, especially where there is a hot summer and a cold winter. This fact is manifest in China where the map of the annual potential evapotranspiration (Fig. 2) bears some resemblance to the July temperature map. The isarithms of 85.5 cm. of annual potential evapotranspiration follow roughly the July isotherms of 28° C. in many places. This same isarithm also approximates the landward limit of the prevailing summer monsoon in China proper. In Manchuria and the northwestern part of China proper a general areal correspondence between the isarithms of annual potential evapotranspiration and certain July isotherms is also noticed.

[1] C. W. Thornthwaite, "An Approach Toward a Rational Classification of Climate," *Geographical Review*, Jan. 1948, pp. 55–94.

[2] The assumption that with a mean monthly temperature of O° C. evapotranspiration will be nil has been questioned by many climatologists. See P. R. Crowe, "The Effectiveness of Precipitation. A Graphic Analysis of Thornthwaite's Climatic Classification," *Geographic Studies*, Vol. 1, No. 1 (1954), p. 50.

The closer spacing of the isarithms of annual potential evapotranspiration in South China than in Central China, however, reflects mainly the influence of winter climatic conditions. In summer when the surface temperatures of the prevailing air mass in South China (Equatorial maritime air mass) and in Central China (Tropical maritime air mass) are not appreciably different, values of the monthly potential evapotranspiration in these two areas are comparable. For example,

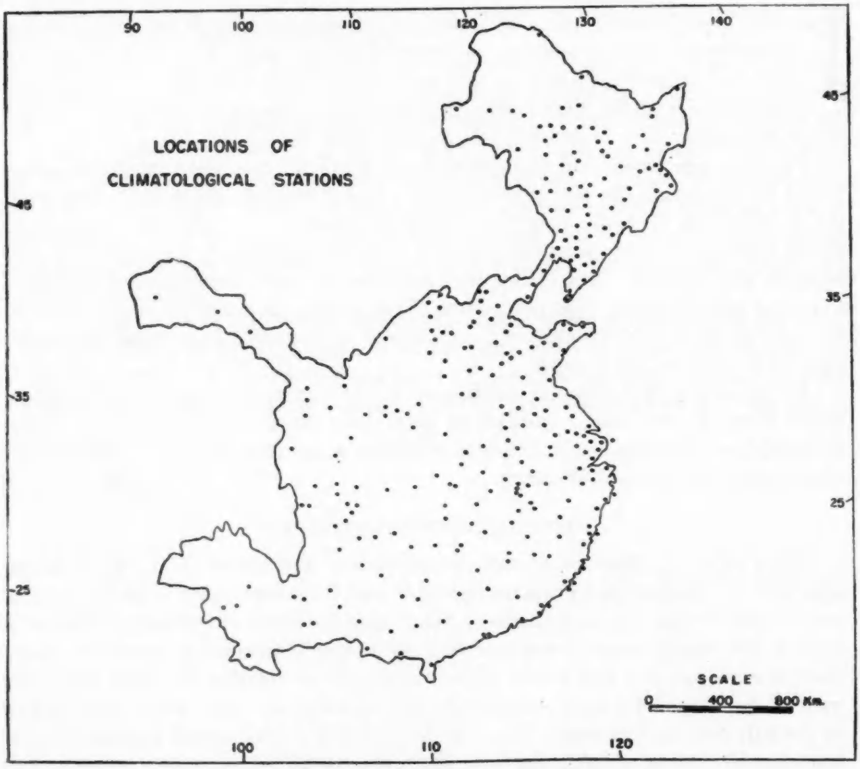

FIG. 1. Locations of Climatological Stations.

Puchi (29° N.) and Canton (23° N.) have the same value of potential evapotranspiration in July, i.e., 17.8 cm. But in January the potential evapotranspiration of the former is 1.0 cm. as against 3.4 cm. for the latter. The rapid increase of the potential evapotranspiration south of the Nanling Mountains in winter months is due largely to the presence of the warm, sea-transformed polar continental air mass in that area.[3]

[3] G. S. P. Heywood and C. W. Jeffries, *Upper Temperatures and the Properties of Air Masses over Hong Kong*, Royal Observatory, Hong Kong, 1941, p. 8.

MOISTURE INDEX

Thornthwaite's moisture index is obtained by comparing the available water with the water need (or potential evapotranspiration) of the climate. He gives the formula: Moisture index $= \frac{100s - 60d}{n}$, where s is annual water surplus, d is annual water deficiency, and n is water need.

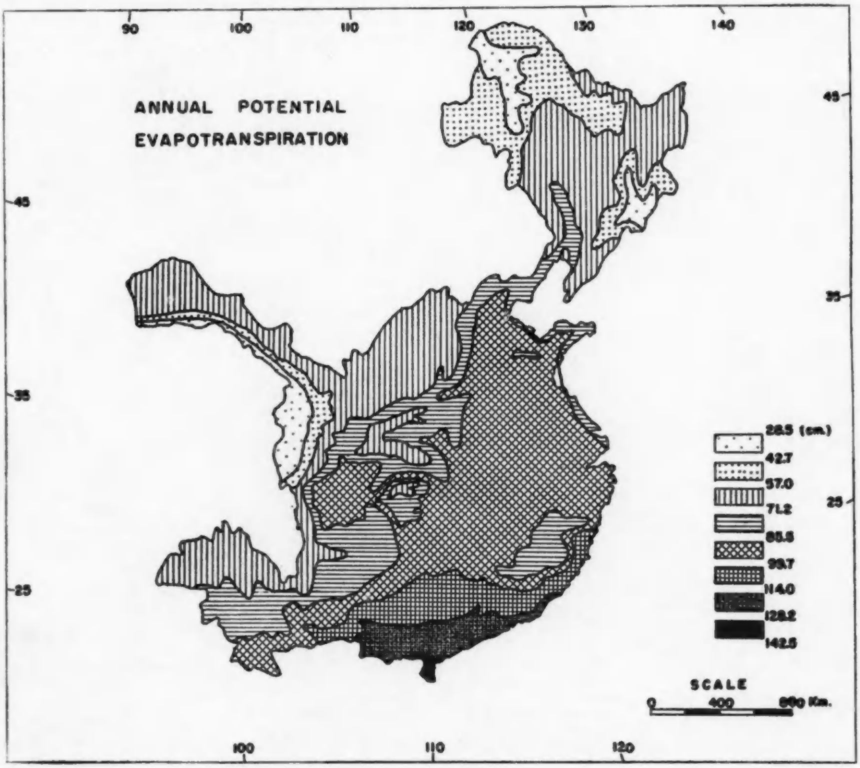

FIG. 2. Annual Potential Evapotranspiration.

Although neither the annual water surplus nor the annual water deficiency is used as an item in his system of classification, both are of great practical significance. The amount of annual water surplus gives an approximate knowledge of the average runnoff of a place while water deficiency provides information in irrigation planning. For these reasons, maps of annual water surplus and water deficiency in China proper and Manchuria are also constructed and presented. They clearly show that there is a large water surplus in the greater part of South China and a water deficiency in North China (Figs. 3 and 4).

Since the moisture index is a function of both precipitation and temperature (in terms of potential evapotranspiration), its isarithms cut across the isohyets in places. The allowance for temperature in relation to precipitation effectiveness is a great advance toward our understanding of the actual moisture condition of a

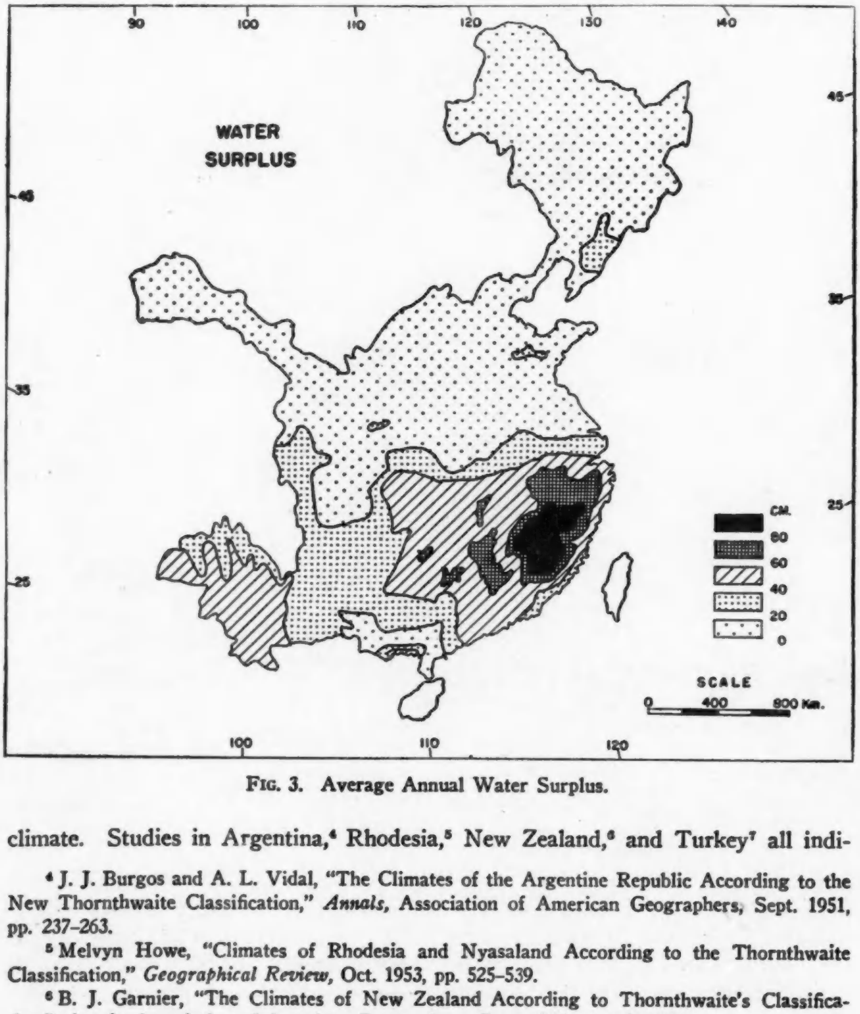

Fig. 3. Average Annual Water Surplus.

climate. Studies in Argentina,[4] Rhodesia,[5] New Zealand,[6] and Turkey[7] all indi-

[4] J. J. Burgos and A. L. Vidal, "The Climates of the Argentine Republic According to the New Thornthwaite Classification," *Annals*, Association of American Geographers, Sept. 1951, pp. 237–263.

[5] Melvyn Howe, "Climates of Rhodesia and Nyasaland According to the Thornthwaite Classification," *Geographical Review*, Oct. 1953, pp. 525–539.

[6] B. J. Garnier, "The Climates of New Zealand According to Thornthwaite's Classification," *Annals*, Association of American Geographers, Sept. 1946, pp. 151–177.

[7] Sirri Erinc, "Climatic Types and the Variation of Moisture Regions in Turkey," *Geographical Review*, Apr. 1950, pp. 224–235.

cate that the moisture index succeeds in differentiating the major moisture regions and that its distributional patterns display a general sympathy with those of soil and vegetation. This distributional correspondence is plainly of geographic significance, for, as Hare said, "the natural vegetation is at least in some measure a measure of its economical potential for settlement."[8]

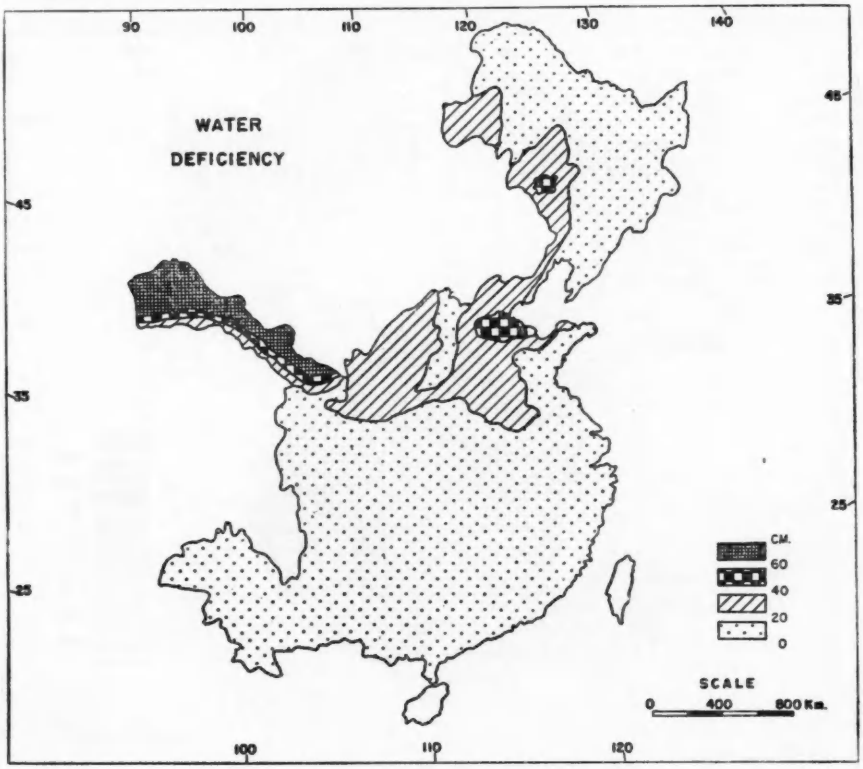

FIG. 4. Average Annual Water Deficiency.

The zero isarithm of moisture index separates the generally dry climates from the generally moist climates. Theoretically it is the boundary between the pedocals and pedalfers. This seems to be true in China where, with the exception of Shantung, the moisture index (Fig. 5) fits well with Thorp's soil map[9] (Fig. 6). Some

[8] F. K. Hare, "Climatic Classification" in *London Essays in Geography* (Harvard University Press, 1951), p. 133.

[9] James Thorp, *Geography of the Soils of China*, The National Geological Survey of China (Nanking, 1936).

of the minor discrepancies between the zero isarithm of moisture index and the soil boundaries in Figure 6 are probably caused by the improper interpolation of the climatic data in the mountainous areas on the moisture index map.

In North China and the northwestern part of China proper the areal distribution of Thornthwaite's semiarid (−20 to −40) and arid (−40 to −60) climates is not greatly different from that of Köppen's BS (semiarid) and BW (arid) cli-

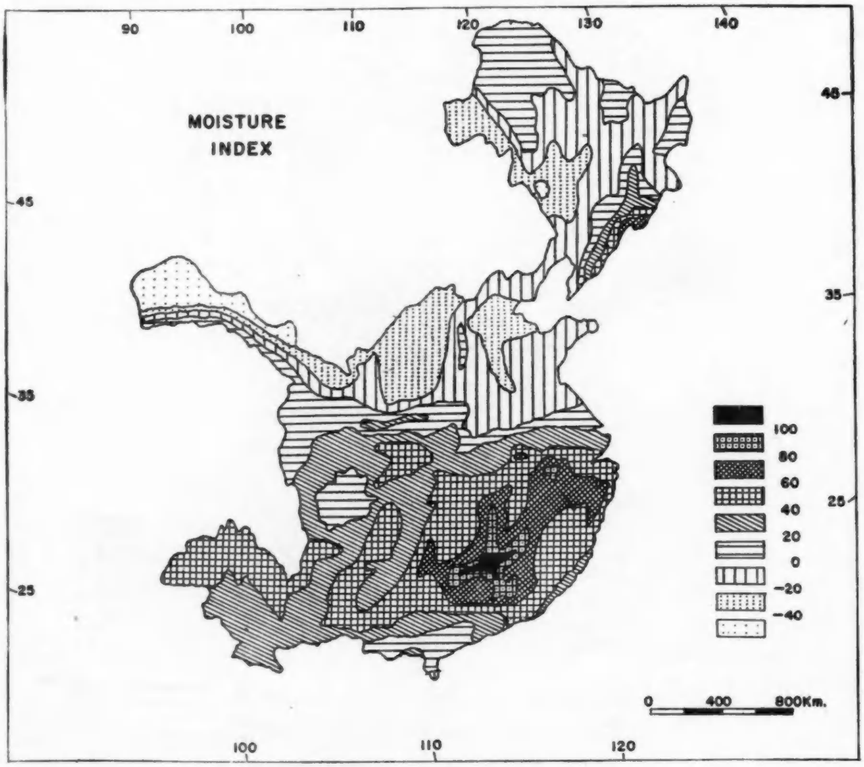

FIG. 5. Moisture Index. Over 100, perhumid; 20–100 humid; 0–20 moist subhumid; −20–0, dry subhumid; −40–−20, semiarid; below −40, arid.

mates.[10] But in Manchuria the moisture conditions portrayed by the two systems are widely divergent. The semiarid climates of western Manchuria in Thornthwaite's map are not regarded as such according to the Köppen classification. Field observations, however, seem to favor Thornthwaite's classification. A study

[10] J. R. Borchert, "A New Map of the Climates of China," *Annals*, Association of American Geographers, Sept. 1947, p. 171.

by Küchler and Takenouchi confirms that the greater part of western Manchuria has a savanna or steppe type of vegetation, indicative of a semiarid climate.[11]

The aridity of the western Manchuria Plain is readily understood in view of the fact that it is located far from the source regions of summer monsoons and in the lee of hills which remove much of the moisture from the tropical maritime air mass in summer. The relatively high value of the moisture index in the Great Khingan Mountains is the result of the low water need in the cold climate of high mountains.

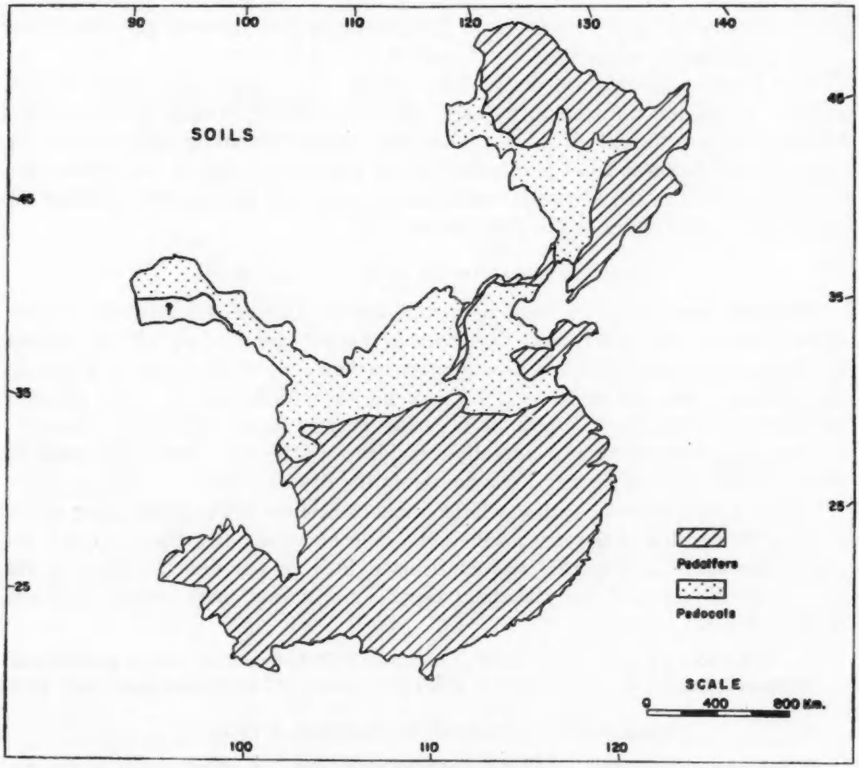

FIG. 6. Soils (after Thorp).

The distinction of subhumid (−20 to +20), humid (20 to 100), and perhumid (above 100) climates is a great merit of the Thornthwaite classification. The omission of such gradation simply abandons much useful information. The climatic conditions of Southwestern China provide a case in point. According to Köppen's classification the climate of the Szechuan Basin is not differentiated from that of

[11] A. W. Küchler and M. Takenouchi, "A New Vegetation Map of Manchuria," *Ecology*, Oct., 1948, pp. 513–516.

Kweichow (Cwa type). But according to Thornthwaite, Kweichow has a humid climate and Szechuan a subhumid one. Testimony to the lower values of moisture index in Szechuan than in Kweichow is the higher pH value of the surface soil in the former area.[12] From a climatic point of view it is not surprising that one of the oldest major irrigation projects was constructed in the Chengtu Plain, originally not profusely watered and "unfit for human habitation."[13]

The Luichow Peninsula and its adjacent area have the only subhumid climate in South China. There the precipitation amount is no less than at most other stations in Kwansi and Kwangtung. The relatively low value of moisture index is caused primarily by the high water need in the hot climate.

The Nanling Mountains are the only area in China where the climate is perhumid. In winter the contact between the sea-transformed and the land-transformed polar continental air masses takes place there;[14] in spring and autumn the movement of the polar front is retarded by the rugged topography; in summer the orographic uplift of the equatorial maritime air mass and the tropical maritime air mass further contributes to the abundant rainfall.

SEASONAL VARIATION OF EFFECTIVE MOISTURE

With the exception of a small area in northern Kiangsi and southern Hupeh, where there is a moderate water deficiency in a moist climate (*w*), all the stations in China proper and Manchuria belong either to the *r* type or the *d* type in Figure 7. The symbol *r* means that there is little or no water deficiency in moist climates while *d* means that there is little or no water surplus in dry climates. Therefore the boundary between *r* and *d* actually coincides with the zero isarithm of moisture index which separates the moist climates from the dry climates.

That in China there is neither a large water deficiency in the moist south nor a large water surplus in the dry north is the only important fact that Figure 7 reveals. Beyond this, Figure 7 has contributed little to our understanding of the climatic conditions in China. Perhaps Garnier's criticism[15] may be borrowed and duplicated here:

> . . . Thornthwaite's new classification . . . fails to indicate tendencies toward seasonal contrasts in seasonal (moisture) efficiency which observations and experience suggest are there.

SUMMER CONCENTRATION OF THERMAL EFFICIENCY

Summer concentration of thermal efficiency is the percentage ratio of the potential evapotranspiration of the three warmest months to that of the annual total. In general, the value of summer concentration of thermal efficiency rises with the increase of latitude and with the decrease of annual index. Thornthwaite has given

[12] James Thorp, *op. cit.*

[13] W. H. Mallory, *China, Land of Famine* (American Geographical Society, 1926), p. 144.

[14] Alfred Lu, "The Winter Frontology of China," *Bulletin of American Meteorological Society*, Oct. 1945, pp. 309–314.

[15] B. J. Garnier, "Thornthwaite's New System of Climate Classification in Its Application to New Zealand," *Transactions*, Royal Society of New Zealand, June, 1951, pp. 87–103.

an equation showing the normal relationship between the summer concentration and the annual index. "The extent to which the summer concentration fails to meet the requirement," he further remarked, "is a measure of its abnormality." In China the most conspicuous abnormality is found in Yunnan (Fig. 8). For example, Kunming has an annual potential evapotranspiration of 77.8 cm. and normally should have a corresponding value for summer concentration of about

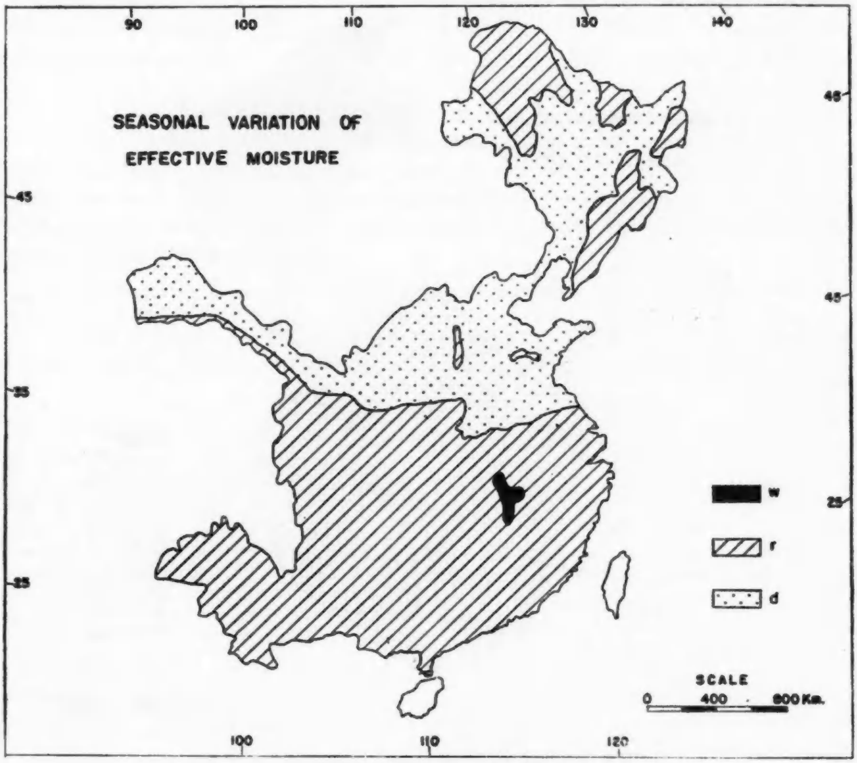

FIG. 7. Seasonal Variation of Effective Moisture.

59 percent. The actual value is only 39.9 percent. The low value of summer concentration in the Yunnan Plateau signifies the dominant influence of one and the same air mass throughout the year, i.e., Superior air mass. In Kunming the thermal oscillation is indeed so small that its annual temperature range is only 10° C., the smallest in China. Toward the east Kweichow Province, as the influence of the dry and warm Superior air mass becomes less profound, the value of summer concentration rises by about 8 percent and the annual cloudiness increases rapidly from 4 to 8.

Another interesting phenomenon in Figure 8 is the southward bulge of the isarithms of 56.3 and 51.9 percent of summer concentration at about 100° to 115° E longitude. The bulge is most conspicuous in the Lake Basin where there is a "cold pocket" or a tongue of the land-transformed polar continental air in winter, indicated by the southward looping of isotherms. In summer the so-called "heat axis" stretches in the same longitudinal zone from southern Hunan northeastward

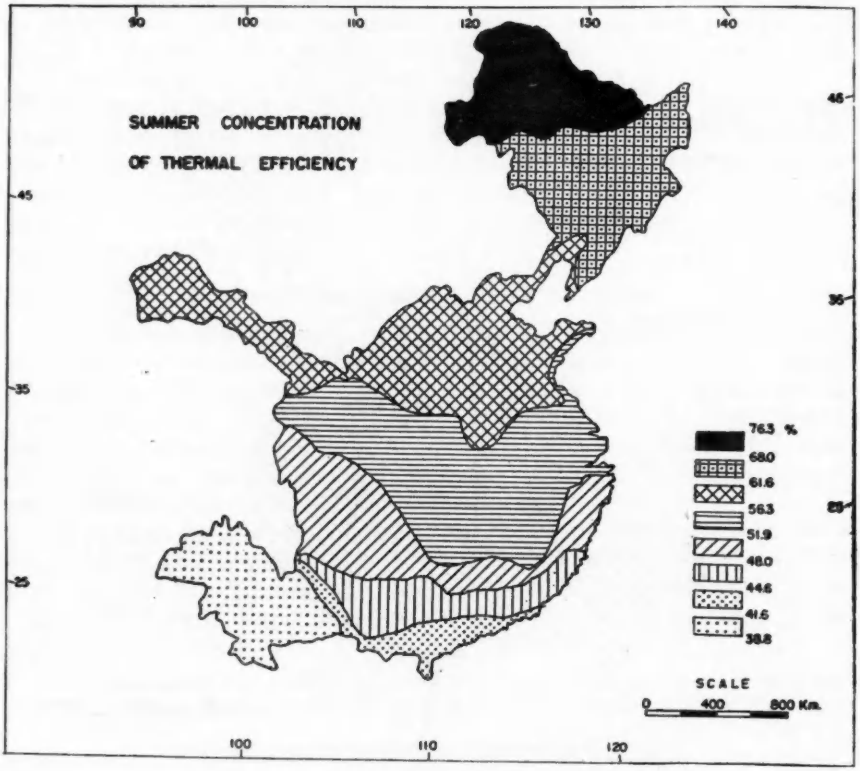

FIG. 8. Summer Concentration of Thermal Efficiency.

through the Lake Tungting Basin to the North China Plain.[16] This axis contrasts with the coast to the east and the highlands to the west, both of which are cooler.

CONCLUSION

The concept of potential evapotranspiration put forward by Thornthwaite in 1948 is a most stimulating and revolutionary one in the field of climatology. Al-

[16] David K. F. Loa, "Climatic Atlas of China Proper," Clark University Ph.D. dissertation, 1944.

though his formula of computing potential evapotranspiration is empirical and the calculated value differs somewhat with the actual amount of evaporation in the Monsoon Land of East Asia,[17] it is demonstrably true that his moisture index fits well with the distribution of soil and vegetation in China. It is in this respect that the new Thornthwaite classification achieves the greatest success.

Seasonal variation of effective moisture and summer concentration of thermal efficiency are items of only moderate significance. The map of summer concentration of thermal efficiency is not explicit because it is the anomaly rather than the absolute value of summer concentration that is of climatic meaning. In fact, the use of these two climatic items has made the classification excessive and cumbersome. Analyzing the climatic data of 104 stations in India, Pakistan, and Burma, Shanbhag found that the Thornthwaite 1948 classification gave each station a different climatic type when all his four symbols were rigidly adhered to.[18] In China the total number of climatic types according to this classification runs to well over 100. Therefore it is almost impossible to employ the Thornthwaite classification to delimit climatic regions.

[17] C. S. Ramages, *Evapotranspiration Measurements Made in Hong Kong,* Royal Observatory, Hong Kong, June, 1953, p. 3.

[18] Gopal Yeshwant Shanbhag, "Classification of the Vegetation of India, Pakistan, and Burma According to Effective Precipitation," Doctoral thesis, Bombay University, 1945.

A COMPREHENSIVE METHOD OF MAPPING VEGETATION*

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THE PURPOSE

THE usefulness of vegetation maps is appreciated by a steadily growing number of people in many different occupations. Examples of this usefulness have been given recently,[1] and the wide and favorable response encourages this author to present a method of mapping vegetation at large scales which may be found applicable to a considerable variety of uses.

It is the purpose of this paper to describe and explain in detail every step of this method of mapping vegetation in order to permit its application elsewhere. Only tests in field and laboratory and the quality of the resulting maps can ultimately reveal the real value of the method. For the sake of improvement and further refinement of this method, the author would be happy to receive comments and criticisms from those who have tried it. The method was developed in the years 1952 to 1954 when various classifications of vegetation and mapping methods were investigated theoretically and tested in the field. The resulting method is considered satisfactory for many purposes. It is based on the idea of mapping vegetation in such a comprehensive manner that the results of the field work can be applied to a maximum number of vegetation classifications. In the laboratory, therefore, the field notes can presumably be manipulated so as to fit a particular classification, whether existing or yet to be devised. Accordingly, comprehensive field mapping is done only once but the result of the field work can be employed as a basis for a variety of vegetation maps, each of which is to serve a different purpose.

FIRST LABORATORY ACTIVITY

Before actual mapping in the field can begin, some work must be done in the laboratory. The first step is to obtain a complete set of aerial photographs of the area to be covered. The photographs should be as recent as possible. The scale of the photographs is often 1 : 20,000, but if the photographs are specially taken for a map, it is much better to have them done at 1 : 10,000 and printed on glossy paper. In our field work we had at our disposal a set of aerial photographs at 1 : 20,000 ten years old and another set at 1 : 10,000 taken immediately before the field work began. The contrast was very striking: the newer, larger-scale photographs were vastly superior.

An investigation of the photographs reveals different types of vegetation. The

* The ideas presented in this paper evolved in connection with a research project sponsored by the Office of Naval Research. The author wishes to express his appreciation of the cooperation of the O. N. R., in particular for preparing a set of large-scale aerial photographs.

[1] A. W. Küchler, "Some Uses of Vegetation Maps," *Ecology*, Vol. 34 (1953), pp. 629–636.

contrasts between various types of vegetation range from strong to very subtle but every contrast should be noted. A good stereoscope, preferably of the mirror type, is a great help though not essential. Every area which is at all different from neighboring areas is bounded by a line of ink drawn directly on the photograph. In this manner all types of vegetation are outlined on the photograph. No omissions should be tolerated with the thought that it will be easier or better to establish the line when in the field.

All boundaries of every vegetation type should be on the photograph before going into the field. This means that there is a definite line on the photograph which can be checked in the field. If the line is acceptable it need not be touched. If the location of the line is unsatisfactory, it can only be so for specific reasons. Thinking and careful observation are then required before a line can be moved on the photograph to a more accurate position.

If, however, the line had not been drawn at all, in the hope of establishing its location while in the field, the difficulties may be serious and the results unsatisfactory. For instance, it is difficult to walk about in a forest of mixed composition and determine where to draw a line. And if a place has been selected for a line, it may be difficult to locate it on the photograph.

The decision where to draw a line on the photograph, separating one type from the next, is not always easy to make. Certain considerations made prior to drafting these boundary lines will save much confusion.

One is, of course, the problem of transitions. Some transitions are so gradual that there may, in fact, be no place where a line is justified. It is then necessary to decide how much admixture may be tolerated in an established type, and to draw the line on the basis of this decision. As this applies to all types it may follow that two types become separated by a rather wide strip of vegetation in which they are both represented. A transition strip can be shown as such, but if it is wide, it may be desirable to further divide it according to the dominance. If A and B are two vegetation types which merge gradually, they should be shown where they occur as clear types, and the transition near A can be shown as A with some admixture of B, and the transition near B may be shown as B with some admixture of A. There are several possibilities that may occur in addition to a simple transition zone. For instance, "islands" of A, or of A with an admixture of B, may occur in the area of B, or of B with an admixture of A. Every area should be singled out on the photograph and receive its ink boundary. Boundaries are often no more than an expedient. Even if the place for the boundary in a transition zone has been selected very judiciously, field inspection may reveal little difference, if any, on the two sides of the boundary.

Another problem concerning these boundaries is the smallest size of an area to be bounded. When is an area too small to be considered? At times, a given type of vegetation contains an "island" of a very different type. Should this be ignored? That depends on the scale of the map which is to be based on this field investigation. If the scale is not known, it may be assumed to be approximately one half of that

of the photograph. If the scale is known, even though only approximately, then the problem is easy to solve. One need only enlarge the minimal area of the final map to the scale of the photograph. If the "island" is smaller than this minimal area, then it should be ignored; if it is as large or larger, then it should be shown. The minimal area on the final map should be not less than 2 millimeters in diameter if round and not less than 1 millimeter wide if the shape is long and narrow. This is especially true of colored maps. On black and white maps the minimal area is usually larger, depending on the type of patterns to be used.

It is very useful to calculate the actual field size of the minimal area. Let us assume, for instance, that the map is to be published at the scale of 2 inches to the mile (1:31,680), and that the minimal area is to be 2 millimeters in diameter. Then a distance of 2 mm on the final map corresponds to 2×3.168 or 6.336 mm on the aerial photograph (scale 1:10,000) and to 63.36 meters in the field. This is roughly 200 feet. In this particular instance the minimal area to be considered in the field should therefore have a diameter of not less than 200 feet.

At times, the ground cover in the form of forbs, grasses, or dwarf shrubs may be largely absent throughout a forest but well developed in open spots, as along trails, fallen trees, abondoned roads, rock outcrops, etc. Such bits of ground cover can usually be ignored. It may, however, be wise to make an appropriate note in the notebook for future reference.

For instance, an interesting item, too small to map but worth entering in the notebook, was observed where a logging road sufficiently disturbed the soil to produce its own plant community. The species listed in column 1, below, occurred exclusively on the road, i.e., in or between the ruts. The species in column 2 grew on the surrounding forest floor and not one of them occurred on the road.

Column 1	*Column 2*
Agrostis alba	Clintonia borealis
Leontodon autumnalis	Cornus canadensis
Lycopus americanus?	Gaultheria procumbens
Oxalis corniculata?	Maianthemum canadense
Plantago major	Mitchella repens
Poa sp.	Osmunda Claytoniana
Prunella vulgaris	Pteridium aquilinum, var. latiusculum
Ranunculus acris	Vaccinium angustifolium
Scirpus rubrotinctus?	
Veronica officinalis	
Viola blanda	

A third problem arises where natural and cultural vegetation appear side by side on the same map. Obviously the divisions of the natural vegetation do not apply to the cultural vegetation, and it is necessary to establish special divisions for the latter. The natural vegetation may be forest, which can be broken down into

deciduous forests and coniferous forests or into oak forests and pine forests and may be further subdivided according to other species that may be listed, or according to height, density, undergrowth, etc. The cultural vegetation may consist of cultivated fields, pastures, vineyards, orchards, golf courses, etc., with urban areas distinguished as separate units. It is useful to consider such divisions carefully before going into the field and to draw the boundaries on the photographs accordingly.

When all boundaries are drawn on the photographs, it is important to make sure that all marginal boundaries are continued on the adjacent photographs.

Further preparations for field work include the acquisition of appropriate equipment and a well trained staff. Equipment includes pencils, fountain pens and ink, paper, clip boards, notebooks, binoculars (the more powerful, the better), draftsman's triangle (right angle, isosceles), measuring tape, topographic maps, and whatever is necessary for the personal comfort of each party member. Cameras are not strictly necessary but very desirable. If more than one camera is available, one should be used for color film and one for black and white film. For photographs in forests the camera with black and white film, placed on a tripod, assures the best result. A good exposure meter prevents serious failures. Photographs are useful when analyzing the field notes in the laboratory. In the notebook a special section should be set aside to record the photographs, i.e., the number of the plant community on the list (see below), with number of film and of the individual exposures. It is also useful to take along a topographic map on which the exact place where a photograph is taken can be shown by a small cross with an arrow to indicate the direction, and the number of the photograph.

Information gathered in the field should be placed on paper specially prepared for this purpose. A master copy can be made in the laboratory and mimeographed copies should be available in plentiful supply.

The note paper used by this author was divided into four columns to permit the maximum amount of information in a clear and orderly fashion. The first column contains the numbers of the areas inspected. The second column shows the general appearance of the vegetation, i.e., its physiognomy and structure. The third column describes the floristic composition of the vegetation, i.e., of what species it is composed, as well as cover and sociability.[2] The fourth column is for useful remarks of any kind.

A major consideration for vegetation mapping is the careful selection of an appropriate staff. Under certain circumstances a party of one is adequate. However, this means that this one person must know how to observe physiognomy, landforms, and many other details. He must have a very thorough knowledge of the flora, he must carry notebook, aerial photos, clip board, camera, binoculars, and often a rain coat, lunch, and other items. It is much better to have more than one

[2] The terms "cover" (*Deckungsgrad* or *Gesamtschätzung*) and "sociability" (*Häufungsweise* or *Sozialbilität*) are here used as defined in J. Braun-Blanquet: *Pflanzensoziologie* (Wien: Springer Verlag, 1951), pp. 58–66.

person in the party. This author worked with two assistants and found this number approached the ideal. If the party consists of more than one person, one should be a botanist, more specifically a well trained taxonomist. Ideally, such a taxonomist has specialized in the flora of the region to be mapped. His only equipment is the latest edition of a standard flora covering the region, such as *Gray's Manual of Botany*, 8th ed., for the northeastern United States. It is best to have the names of all species based on the same manual, as there are variations from one manual to the next, and the use of different sources leads to confusion.

It is of advantage to have the entire party thoroughly familiarized with the aims and methods of the field work. All members of the group should be well acquainted with the physiognomic classification and Braun-Blanquet's methods of analyzing plant communities.[3] There are many cases calling for relatively arbitrary decisions in the field, and an intelligent discussion among the staff members helps in making the decisions as reasonable as possible.

FIELD WORK

With staff and equipment assembled, the party can proceed to the field. Here it becomes necessary to visit every individual area outlined on the aerial photographs. It must be remembered that the information is to be as complete as possible but that aerial photographs show only the surface layer of the vegetation. What grows under the canopy of a forest can only be discovered by direct observation. In deserts and at the high altitudes of alpine terrain, the paucity of vegetation types and the simplicity of their structure and composition permits one, after much practice, to recognize types accurately from a distance, e.g., across a valley, if strong binoculars are available. In all other areas it is imperative that each vegetational area outlined on the photograph be inspected.

Upon arrival in a given area to be inspected, the first task is to walk about in it, preferably from end to end and across, observing the vegetation critically. Thereupon all relevant data are entered on the blank which is carried on a clip board.

It is necessary to know in advance just what to look for, and then, in the field, to look for it with unwavering consistency. Once it has been established which aspects of the vegetation to consider, it is absolutely necessary to consider them uniformly throughout the region mapped, with no exceptions. For instance, it is not permissible to observe and record in the field notes the height of the vegetation in one area and then ignore it in another area. If the height of the vegetation is to be recorded, it must be recorded in every area, i.e., for each individual vegetation type. This insistence on being consistent at all times pays big dividends later on, when the field work has been completed and the maps are being prepared in the laboratory.

Recording good notes is at times difficult in the field. To make sure that the notes remain legible for some time, the script should be reasonably large. It is

[3] Cf. A. W. Küchler, "The Relation between Classifying and Mapping Vegetation," *Ecology*, Vol. 32 (1951), pp. 275–283.

very desirable to type the field notes as soon as possible. This is important because pencil notes become increasingly difficult to read and are blurred after some time. On the other hand, it is not good to rely on a fountain pen because in wet weather writing with ink is difficult, the paper absorbs moisture, the ink runs, and the notes are soon quite illegible.

It is, of course, necessary that every area outlined on the aerial photographs can be correlated with the field notes. For this reason, every areal unit which appears on a photograph must be numbered, and the same number must appear in the field notes where the vegetation of this area is described.

When the vegetation of a given area has been inspected critically, its salient features must be recorded on the prepared sheets. The first step is to give the area its number. The numbers are entered consecutively on the sheets and on the photographs. No numbers may be written on the photographs until a given area has been inspected. Then its number is written down in the field notes and on the photograph simultaneously. The next number is not set down until the next area has been inspected and analyzed. In this manner, area follows area, each with its own number. The numbers are written into the first column on the prepared sheets. If an area is inspected in which the vegetation is the same as in another area already inspected, it nevertheless receives its own number, and the character of the vegetation is recorded anew. This is not necessary for such types as barren, urban, etc.

In column 2, designated "Physiognomy," the appearance and structure of the vegetation is recorded. We use the physiognomic classification prepared by this author[4] for mapping purposes; Table 1 summarizes it. However, rather than relying on this table, it is necessary to study the original text carefully, so that the system may be applied accurately and without leaving any doubt. A good description of the structure of the vegetation is of tremendous help when preparing the maps in the laboratory.

The physiognomic classification reveals the structure of the plant communities (vegetation types), i.e., height and density of every item listed, and, in addition, such special features as may be present. The physiognomic formulae are usually simple but can be very complex. They should always be recorded as accurately and as completely as possible. In the majority of cases the meaning of the formula is clear. However, the combined information of physiognomic formula and floristic description may not suffice to indicate which layer of the vegetation is composed of which species. For instance, if the formula is Dls (a layer of deciduous low trees and one of deciduous shrubs), and if the flora is birch and oak, then it may be that both layers are composed of birch and oak, intimately mixed. But if one of the two species is largely restricted to one layer only, neither the formula nor the floristic listing would indicate this. It is then best to make an appropriate note in column 4.

[4] A. W. Küchler, "A Physiognomic Classification of Vegetation," *Annals*, Association of American Geographers, Vol. XXXVII (1949), pp. 201–210, and "Die physiognomische Kartierung der Vegetation," *Petermanns geographische Mitteilungen*, Vol. 91 (1950), pp. 1–6, with two colored maps.

The density of the vegetation is estimated in accordance with the physiognomic classification. Such estimates rarely present difficulties. The height of the various layers of vegetation can be measured, and after some practice it can be estimated with a considerable degree of accuracy. It is very useful to know the height of ½ meter and of 1 meter with regard to one's body (e.g., one's knee may be ½ m above the ground), as these are the critical heights separating shrubs from dwarf shrubs, and low from medium tall herbaceous plants.

TABLE 1

PHYSIOGNOMIC CLASSIFICATION OF VEGETATION

CAPITAL LETTERS:

Woody Vegetation:		Herbaceous Vegetation:	
B:	evergreen broadleaf	G:	graminoids
D:	deciduous broadleaf	H:	forbs
E:	evergreen needleleaf	L:	lichens and mosses
N:	deciduous needle leaf		
O:	without leaves		

SMALL LETTERS:

Group I: Height:

t:	tall;	minimum height of trees	25 m
		" " " herbaceous plants:	2 m
m:	medium tall;	height of trees:	10–25 m
		" " herbaceous plants:	½– 2 m
l:	low;	maximum height of trees:	10 m
		" " " herbaceous plants:	½ m
s:	shrubs;	minimum height:	1 m
z:	dwarf shrubs;	maximum height:	1 m

Group II: Density:

c:	continuous growth
i:	interrupted; plants usually do not touch
p:	plants scattered singly, or in groves or patches
r:	rare, yet conspicuous
b:	barren; vegetation largely or entirely absent

Group III: Special Features:

e:	epiphytes	u:	palms
j:	lianas	v:	bamboos
k:	succulents	w:	aquatic vegetation
q:	cushion plants	y:	tree ferns and tuft plants

For measuring the height of trees a measuring tape and a plastic draftsman's triangle (right angle, isosceles) suffice. The height of the tree equals the observer's distance from the tree when he looks along the hypotenuse and its extension toward the tree top (Fig. 1). The height of the observer's eye above the ground should be added to the distance from the tree for greater accuracy. Care must be taken that the lower side of the triangle is horizontal. To assure the best results most easily, the height of the observer's eyes above the ground is marked on the bark of the tree. Then the observer moves away from the tree until the tree top coincides with the upper tip of the triangle. To make sure that the lower side of the triangle is horizontal, it may be placed on the tripod as high as the observer's eyes. The

triangle's lower edge must then point to the mark on the tree which indicates the height of the eyes above the ground. If the tree stands on a slope, observations are made along the contour.

It takes very little time to become acquainted with the physiognomic classification, and its application in the field is simple and quick. After the formula for a particular vegetation type has been established and entered in column 2, the attention is focused on the floristic character of the vegetation.

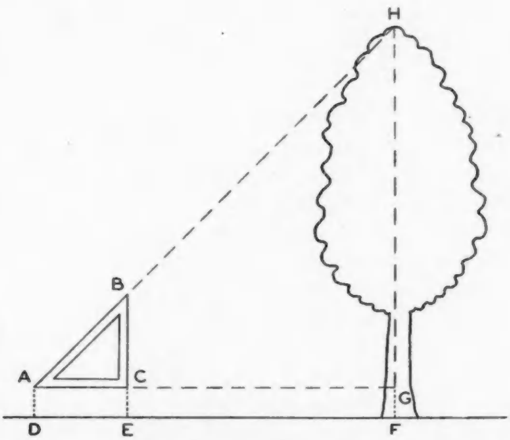

FIG. 1. ABC: triangle; AB: Hypotenuse; BH: extension of hypotenuse to tree top; A: position of observer's eye; AG: distance of observer from tree; AD = CE = GF: height of observer's eye above ground; AG = GH; FH: height of tree; DEF: ground; ACG: must be horizontal.

In analyzing the flora the following points should be kept in mind. The species must be identified by name, and its coverage must be determined, as well as its distribution within the area (sociability). The taxonomist is usually able to identify all species on sight. When he is in doubt, he can nevertheless give the species a name that can be entered on the list, followed by a question mark. He can then collect a specimen and identify it accurately upon returning to the camp and to his botanical manual. The correct name should then be entered on the list at once. If some doubt about the accuracy of the name persists, the question mark is retained on the list. Only scientific botanical names should be used to identify the plant species, or else the value of the entire work may be seriously impaired.

A mere listing of plant names gives a rather inadequate picture of the character of the flora. For this reason comments are added on coverage and sociability. The former is understood to mean the percentage of ground that would be covered if the full spread of the species were projected vertically to the ground. Sociability refers to the distribution of a species within the area of the vegetation type under consideration. Both coverage and sociability are indicated by numbers which follow

the name of the species, and which are separated by a period, according to the following tabulations:

Coverage	*Sociability*
+ very sparsely present; cover very small	1 growing singly
1 plentiful but < 1/20 of the area	2 grouped or tufted
2 covering 1/20–1/4 of the area	3 in small patches
3 covering 1/4–1/2 of the area	4 in extensive patches
4 covering 1/2–3/4 of the area	5 in great crowds
5 covering > 3/4 of the area	

This method was developed by Braun-Blanquet[5] and is employed all over the world today. The numbers for both coverage and sociability range from one to five but if the coverage is very small indeed, i.e., smaller than 1, then "+" is used.

Coverage is described according to precise limits, although in the field the numbers entered on the list are based on estimates. Sometimes it is difficult to decide on a limit between + and 1, but a little practice and a growing familiarity with the vegetation soon dispel any hesitance. In the case of sociability, the terms are much less precisely stated. If a species grows singly, one specimen here, one there, no difficulties arise. The same is true of great crowds. But the limit between small and extensive patches is often difficult to determine. It is then left to the judgment of the observer to make what seems to him the most reasonable decision. In the field, and when analyzing the flora, the task is to write into the list the name of the species, each one followed by its two numbers, for example: *Pinus rigida* 3.1; if there are several or many species that make up the plant community, then every individual species named must be followed by its own set of numerals, describing its own coverage and sociability.

It is not necessary to list all species, although followers of Braun-Blanquet's school of thought insist that no species be omitted. In the great majority of cases, however, it is adequate to list only those species which are of at least slight prominence in their respective vegetation type. We have quite generally ignored all species of which only very few specimens were present in a given type.

Finally there is column four, designated "Remarks." Here we enter the number of the aerial photograph on which the vegetation type appears, and all sorts of remarks may be made that help throw light on the vegetation. Comments such as "old burn," "recently logged," etc., will prove very helpful when trying to interpret the character of the vegetation. Comments on the physiography, soil, and water condition (bog, etc.) are also useful. Any more elaborate notes should be entered into the notebook that should always be carried along with the prepared sheets. Frequently there is no particular need for any remarks; but the number of the aerial photograph should always be given.

[5] Braun-Blanquet, *op. cit.*

Often the physiognomic formula reveals characteristics of the vegetation that are not evident from the floristic description. For instance, if the flora is described as *Betula papyrifera* 5.1 (birch) and *Abies balsamea* 5.1 (r), we can only see that the vegetation consists of two dominant species each of which covers more than ¾ of the area. This may seem confusing. But the physiognomic formula DmEl gives the explanation. Dm stands for the broadleaf deciduous forest of medium tall trees, and El means small needleleaf evergreens. The formula reveals therefore that the vegetation consists of two layers, an upper one consisting of broadleaf deciduous trees (birches) and a lower one of needleleaf evergreen trees (firs).

Beginners are often disturbed by the breadth of the divisions with regard to both physiognomy and flora. One example: Dm means deciduous medium tall trees. But "medium tall" means anywhere between 10 and 25 meters. Trees 11 meters high and trees of 24 meters (more than twice as high!) are therefore grouped in the same category. This seems unrealistic. Where trees of many different heights occur, as in California, in the southern Appalachians, and innumerable other regions, all is well. But if the vegetation is limited to one or two height classes, then these may seem inadequate. It is usually not advisable to make any changes in an established classification. But where, for reasons of detail, it seems desirable to describe the height of the trees more accurately, a class like "medium tall" may be broken down into two divisions, designated m′ and m″.

Another example: If the coverage of birch reads *Betula papyrifera* 3.1, the implication is that birch may cover anywhere from ¼ to ½ of the ground. Again, the range may seem too wide. But again it may be said that it is best to be satisfied with the existing divisions. While beginners often seem acutely aware of the breadth of these divisions, to the more experienced field man they usually seem reasonable and practical.

Detailed mapping such as presented here does not permit much reliance on aerial photographs for identifying vegetation types. Easy recognition of accurate boundaries is, of course, of the greatest value and makes aerial photographs practically indispensable. But it must be remembered that different types of vegetation may look alike on a photograph, or one particular type may look different in different parts of the photograph. For example, we observed these particular instances: (1) Two different but contiguous vegetation types appeared on the photograph but were fused into one upon field inspection. In this mixed forest the conifers were slightly higher than the deciduous trees in part of the area and the reverse was true elsewhere. The difference in height was negligible from a mapping point of view, being well within one height class. But the camera exaggerated the difference to the extent of showing two different types. (2) Pictures taken during the late spring in a mountainous terrain show a given community as different at different altitudes. The lower temperatures of the higher elevations retard foliation and the development of shoots so that the same community appears like three different communities at three different altitudinal levels.

Burned areas are sometimes difficult to evaluate, depending on the character of the fire. The destructiveness of the fire depends largely on the floristic composition of the vegetation. We found spruce especially susceptible to destruction by fire, pitch pine very resistant. Oak seems more resistant than birch. Moist soil and a dense herbaceous ground cover seem to retard fires and reduce their effect. Wind is also important. If the flames travel very fast they often destroy relatively little; a slow advance may be more disastrous. If the trees have been destroyed only above the ground their roots will produce a dense shrub formation and if the dead trees are still standing or lying about, progress through the burned area may become very difficult. At any rate, column 4 and/or the notebook should receive appropriate comments.

The result of the field work is a set of lists and notes and a series of aerial photographs on which the vegetation types are outlined. Each individual outlined area on the photographs must have received a number which corresponds to the number in the lists where the particular type is analyzed. The critical observations, especially with regard to the lower layers of the vegetation, may necessitate the addition of further boundaries on the aerial photographs. It may also be that boundaries first drawn in the laboratory have to be shifted or removed upon field inspection. If any boundaries have been added or changed on the photographs during the field work, such a change should be made on all photographs on which this boundary appears. Especially if a change on the photograph was made near a corner, this change may have to be repeated on two or even three other photographs; this should be done in the field.

SECOND LABORATORY ACTIVITY

The field work concluded, the party returns to the laboratory. The work of the taxonomist comes to an end. If no typewriter was available during the field work, the first step is to type all lists exactly as they appear on the field note sheets (the lists). They are the basis of all information. If it seems desirable to rearrange the various items on the lists, then this should be done afterwards. It is always possible to make any number of changes. But it is of fundamental importance to have the original field data typed just as they were first set down. The contents of the notebook should be typewritten too.

The next step is the preparation of the base map. This is a map which shows the exact outline of each individual vegetation type, i.e., each area shown separately on the photographs, and the numbers of the areas. In order to make this map it is best to transfer the lines (boundaries of vegetation types) on the aerial photographs to the topographic map. It is not feasible to trace the lines directly from the photographs on white paper because of the distortion on the photographs. The topographic quadrangles with streams, roads, lakes, coastlines, houses, and other features help overcome this difficulty. Once all boundary lines have been transferred to the topographic map, they can be traced on white paper, but preferably on a stable base to maintain the constancy of the scale. On this drawing it is best to

add lake and ocean shores, if any, to assist orientation. Then the numbers of all vegetation types, i.e., of all areas shown on the photographs, are entered on this map. Scrupulous checking upon completion is quite essential.

The result of all this labor is a base map of the vegetation of the selected area. It shows the exact outline of every vegetational unit and the number of each unit, which refers to the corresponding number in the lists with its detailed description of the vegetation type. All the basic work has now been completed, and the outline map, with its numbers, and the lists form the foundation for the vegetation map (or maps) to be drawn.

The preparation of the final vegetation map depends on what particular classification is to be selected. This may be physiognomic or floristic or a combination of the two. Perhaps forest trees are the only objects of interest, in which case all undergrowth and herbaceous vegetation can be ignored or lumped, as the case may be. It all depends on the purpose of the map, and according to this purpose, the information on the lists is manipulated so as to produce categories which best serve the purpose of the map. When these categories have been established, one need only go through the lists, assign each unit to the appropriate category and then trace the new map off the base, lumping together all units which are adjacent to each other and of the same category. Obviously, the comprehensive information on the lists lends itself to a great variety of possibilities. Herein lies the chief value of this method.

A NEW METHOD FOR MEASURING MANUFACTURING

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HOW much manufacturing is there in Pittsburgh, in King County, Washington, or in the State of Texas? How important is manufacturing in the economy of these areas? How may the quantity and importance of manufacturing in one of them best be compared with the quantity and importance of manufacturing in the others? Should measurements and comparisons be made on the basis of employment, value added by manufacture, energy consumed, salaries and wages, or in some other way? Answers to questions of this nature should facilitate the progress of manufacturing geography.

The purpose of this paper is to present a method for the measurement of two aspects of manufacturing, magnitude and intensity. Magnitude is used here to mean quantity of manufacturing and intensity refers to the importance of manufacturing in the economy. In contrast to conventional procedures, this method employs the use of multiple criteria.

Numerous geographic studies[1] have dealt with the distribution of manufacturing, and some have discussed problems of manufacturing measurement. Manufacturing regions, subregions, and various other types of concentrations have been identified and delineated. These studies have employed a wide variety of criteria for measuring manufacturing conditions, but usually only one criterion was used in each study. When several criteria were used, each was generally presented on separate maps. In some cases these maps were combined to derive patterns. Value added by manufacture, value of products shipped, production workers, all employees in manufacturing, wages, salaries and wages, power consumed, physical quantity of production, floor space, and other criteria have been used. Some writers have insisted that value added by manufacture is the best criterion for measurement; others have strongly favored power consumed. Figures for employment are perhaps most widely used today because of their common inclusion in censuses and because of their freedom from the problems of deflation associated with statistics involving money.

[1] These include: John W. Alexander, "Industrial Expansion in the United States," *Economic Geography,* Vol. 28 (April, 1952), pp. 128–142; Sten DeGeer, "The American Manufacturing Belt," *Geografiska Annaler,* Vol. 4 (1927), pp. 233–359; Chauncy D. Harris, "A Functional Classification of Cities in the United States," *Geographical Review,* Vol. 33 (1943), pp. 86–99; Richard Hartshorne, "A New Map of the Manufacturing Belt of North America," *Economic Geography,* Vol. 12 (1936), pp. 45–53; Clarence F. Jones, "Areal Distribution of Manufacturing in the United States," *Economic Geography,* Vol. 14 (1938), pp. 217–222; Harold H. McCarty, *The Geographic Basis of American Economic Life* (New York: Harper and Brothers, 1940), pp. 476–504; Helen Strong, "Regions of Manufacturing Intensity in the United States," *Annals,* Association of American Geographers, Vol. 27 (1937), pp. 23–47; Alfred J. Wright, "Recent Changes in the Concentration of Manufacturing," *Annals,* Association of American Geographers, Vol. 35 (1945), pp. 144–166.

SINGLE-CRITERION VS MULTIPLE-CRITERIA MEASUREMENT

A measurement of manufacturing based upon one criterion only is subject to whatever abnormalities that criterion might exhibit. One criterion, therefore, may not provide a good basis for comparison between two areas with different types of industries, with different technique levels, or with widely divergent economies. Employment figures alone, for example, would not adequately serve as a base for comparing the quantity of manufacturing in a highly modernized United States city with that in an area in India where most of the work is done by hand. With advanced knowledge and machinery one employee in the United States city would produce much more than his counterpart in India.

Examples of the inadequacy of single-criterion measurement may be cited even for areas within the United States. In 1939 the Fall River-New Bedford Standard Metropolitan Area had 108 percent the number of employees in manufacturing as the Kansas City Standard Metropolitan Area but produced only 50 percent the value added by manufacture as the Kansas City Standard Metropolitan Area. Which is the more significant here, employment or value added? Which should serve as a basis for comparing the quantity of manufacturing in these two areas? As both employment and value added are wealth-generating phenomena, the best measurement would seem to include the two, and possibly other criteria as well.

Variations can be expected whenever more than one criterion is used for measurement. This paper, therefore, proceeds under the premise that the use of several criteria will provide a more comprehensive and more widely applicable measurement of manufacturing conditions than the use of a single criterion.

A MULTIPLE-CRITERIA METHOD OF MEASUREMENT

The quality and usefulness of a multiple-criteria method depends upon the choice of individual criteria and on the manner in which these individual criteria are combined into the multiple-criteria measurement.

The selection of the individual criteria used was based largely upon two major considerations. First, what criteria seemed appropriate to the kind of measurement desired? Second, for which of the appropriate criteria were statistics commonly enough available to warrant their use?

The method outlined here for the measurement of manufacturing magnitude and intensity requires statistical data of five kinds: (1) all employees in manufacturing, (2) value added by manufacture, (3) salaries and wages, (4) total employed in all industry groups (agriculture, manufacturing, commerce, etc.), and (5) population.[2] The magnitude and intensity of manufacturing may be measured in any area for which these statistics are available.

[2] As far as the United States is concerned, statistics for all employees in manufacturing, value added by manufacture, and salaries and wages may be secured from the various *Censuses of Manufactures;* statistics for total employed in all industry groups and population may be found in the *County and City Data Book* or its predecessor, *The County Data Book,* as well as in other sources. A number of foreign countries also now collect and publish these five kinds of statistics. In this study, 1947 figures for total employed in all industry groups and for population were derived from straight-line projections between 1940 and 1950 data.

Indexes are employed so that unlike phenomena may be added and quantitatively compared. An index was established for each criterion used. The fixed bases for these indexes are the averages of magnitude and intensity conditions found to exist in fifty selected Standard Metropolitan Areas in 1939.[3] These fifty Standard Metropolitan Areas provided a suitable sample for the establishment of reliable numerical relationships between the various criteria for that year in the United States, and their averages were of such size as to be directly employable as fixed bases in light of presumed future uses of the method.

MAGNITUDE RATINGS

Magnitud

Magnitude, as used here, means the quantity or size of the manufacturing activity. Separate ratings are calculated for three criteria of magnitude and are then averaged to secure a multiple criteria rating. The criteria used are: (1) all employees in manufacturing, (2) salaries and wages, and (3) value added by manufacture.[4] The fixed bases represent the averages of each of these criteria in the fifty Standard Metropolitan Areas in 1939. Rounded to simplify their use, they become:

All employees in manufacturing	70,000
Salaries and wages	$100,000,000
Value added by manufacture	$200,000,000

The magnitude rating of each criterion for any area is simply the quantity of the criterion for that area expressed as a percentage of the quantity of the corresponding fixed base. Thus, if the quantity of the criterion for any area is equal to that of the

[3] Although the Standard Metropolitan Areas were not established until after 1939, the Bureau of the Census compiled 1939 data for them in the 1947 *Census of Manufactures.* 1939 was chosen as the base year rather than 1947 because 1947 figures for total employed in all industry groups and population generally had to be secured from straight-line projections between the 1940 and 1950 figures and so were likely to be less accurate than 1939–40 census figures. The Standard Metropolitan Areas used include fifty of the fifty-three which had over 40,000 people employed in manufacturing in 1947. The three omitted are New York-Northeastern New Jersey, Chicago, and Philadelphia.

[4] The criterion "all employees in manufacturing" was used instead of production workers because it was felt that it provides a better indication of the total manufacturing activity. Data on employment are collected in most manufacturing censuses. The criterion "value added by manufacture" approximates the value created in the manufacturing process and is probably the most satisfactory measure of the relative economic importance of manufacturing. Eventually such data will probably be reported in the censuses of most countries. The criterion "salaries and wages" must be used instead of wages so as to maintain consistency with the first criterion. Data on this item commonly are reported in censuses. Within similar economies, salaries and wages may vary almost directly with employment, and of course they are included in value added by manufacture, generally representing about 50% of the latter in the United States. The salaries and wages criterion, however, was deemed sufficiently different from the other two, and a sufficiently good indicator of areal variation in manufacturing quantity, to be included separately in the multiple-criteria rating. Its inclusion as a separate criterion actually gives it additional weight in the formula. It is not surprising therefore that salaries and wages have a higher frequency of close correspondence to the multiple-criteria rating than the other two criteria used. No justification of further weighting of criteria was identified.

fixed base the magnitude rating would be 100. The ratings for the individual criteria used may be expressed as follows:

$$M_1 = \frac{En}{70{,}000} \times 100$$

where M_1 is the magnitude rating based on all employees in manufacturing, En is the number of all employees in manufacturing in the area to be rated, and 70,000 is the fixed base for this criterion.

$$M_2 = \frac{Sn\ K_1}{100{,}000{,}000} \times 100$$

where M_2 is the magnitude rating based on salaries and wages, Sn is the salaries and wages paid in dollars in the area to be rated, K_1 is the conversion factor necessary to convert to the 1939 dollar,[5] and 100,000,000 is the fixed base for this criterion.

$$M_3 = \frac{Vn\ K_2}{200{,}000{,}000} \times 100$$

where M_3 is the magnitude rating based on value added by manufacture, Vn is the value added by manufacture in dollars in the area to be rated, K_2 is the conversion factor necessary to convert to the 1939 dollar,[6] and 200,000,000 is the fixed base for this criterion.

[5] Salaries and wages figures in this paper were converted to 1939 dollars through use of the Bureau of Labor Statistics' "Earnings Index" found in *Monthly Labor Review*, Vol. 70, No. 3 (March, 1950), p. 354, Table C-4 (if 1939 = 100, 1947 = 189.3). Subsequent study of conversion problems seems to indicate that the Bureau of Labor Statistics' "Consumers Price Index for Moderate-Income Families" (all items, Table D-1, *Monthly Labor Review*) is a more suitable deflator.

[6] In this paper the 1947 figures for value added by manufacture were converted to 1939 dollars through use of the Bureau of Labor Statistics' "Wholesale Price Index," *Monthly Labor Review*, Vol. 70, No. 3 (March, 1950), p. 361, Table D-7. The indexes under the column "Manufactured Products" are the most practical deflators to use (1926 = 100, but if 1939 is given a value of 100, then 1947 = 181.6). The "Wholesale Price Index" was revised for years after 1951, and up to the time of this writing the "Manufactured Products" index had not been calculated for the new series. Therefore it may be necessary in the future to use the "All Commodities other than Farm Products and Foods" index in lieu of the somewhat better "Manufactured Products" index.

As the wholesale value of all manufactured products does not increase or decrease at the same rate, more refined results may be obtained by deflating each major industry group (of the Standard Industrial Classification) within an area by the appropriate wholesale price index for that group. The deflated values for the various major industrial groups may then be added to secure a total. This involves additional calculations, and generally not all of the indexes for each major industry group can be found together in one publication. The indexes for each major industry group for the year 1947 are listed together in *Ratio Analysis of Selected 1947 Census of Manufactures Figures for Industries and Industry Groups,* Boston University, College of Business Administration (Boston, Mass., July, 1950), page 11.

The multiple-criteria ratings resulting from both methods of value-added-by-manufacture deflation (i.e., deflation simply through application of the wholesale price index for "Manufactured Products" to the value-added figure for the area to be rated, or deflation through application of separate indexes to the value-added figures of each major industry group) are included in Tables I and II. Multiple-criteria ratings, based on the two methods, were significantly

The multiple-criteria magnitude rating then may be expressed as

$$M_m = \frac{M_1 + M_2 + M_3}{3}.$$

So that rated areas may be placed into broad categories for general comparison and cataloging, ten magnitude classes have been arbitrarily established and given capital letter designations from "A" to "J". The classes are designed to serve the presumed needs of the system when applied to manufacturing areas of all sizes. They are as follows:

Class	*Magnitude Rating*
A	Over 1600
B	800 to 1599
C	400 to 799
D	200 to 399
E	100 to 199
F	50 to 99
G	25 to 49
H	12 to 24
I	6 to 11
J	Less than 6

Intensity Ratings

Intensity

Intensity, as used here, means the importance of manufacturing in the economy. Separate ratings are calculated for three criteria of intensity, and then averaged to secure a multiple-criteria rating. The criteria used are: (1) ratio of all employees in manufacturing to total employed in all industry groups, (2) ratio of all employees in manufacturing to total population, (3) ratio of value added by manufacture to total population (value added per person).[7] The fixed bases represent the averages

different only in those areas which were dominated by one industry group with a wholesale price index value in 1947 considerably above or below the index value for "Manufactured Products." Akron is the outstanding example.

[7] The ratio of all employees in manufacturing to total employed in all industry groups (total employed in all industry groups means employed in all groups of economic activity and should not be confused with major industry groups as discussed in footnote 6) is probably the best single criteria of intensity measurement. It does not, however, consider the total population. Suppose, for example, that there were 500 people in one area and 1000 in another. Suppose further that in both areas 100 people were employed in manufacturing and 300 were employed in all industry groups. Isn't manufacturing of greater importance to the economy in the area with a population of 500 than in the one with a population of 1000 even though the ratio of all employees in manufacturing to total employed in all industry groups is the same? It was felt that it was; so the ratio of all employees in manufacturing to total population was introduced as a second criterion. Obviously the quantity of manufacturing itself should come into the intensity measurement. Therefore the ratio of value added by manufacture to total population was used as a third criterion.

A criterion involving quantity of manufacturing per unit area was considered, but such a measurement would really indicate density rather than intensity as defined here.

of each of these criteria in the fifty Standard Metropolitan Areas in 1939. Rounded to simplify their use, they become:

$$\frac{\text{All employees in manufacturing}}{\text{Total employed in all industry groups}} = .300$$

$$\frac{\text{All employees in manufacturing}}{\text{Population}} = .110$$

$$\frac{\text{Value added by manufacture}}{\text{Population}} = \$310$$

The intensity rating of each criterion for any area is, as in the case of magnitude calculations, the quantity of the criterion for that area expressed as a percentage of the quantity of the corresponding fixed base. The ratings for the individual criteria used may be expressed as follows:

$$I_1 = \frac{\left(\frac{En}{Tn}\right)}{.300} \times 100 \text{ or } \frac{En}{Tn(.300)} \times 100$$

where I_1 is the intensity rating based on the ratio of all employees in manufacturing to total employed in all industry groups, En is as defined above, Tn is the total employed in all industry groups, and .300 is the fixed base for this criterion.

$$I_2 = \frac{\left(\frac{En}{Pn}\right)}{.110} \times 100 \text{ or } \frac{En}{Pn(.110)} \times 100$$

where I_2 is the intensity rating based on the ratio of all employees in manufacturing to total population, En is as defined above, Pn is the population of the area to be rated, and .110 is the fixed base for this criterion.

$$I_3 = \frac{\left(\frac{Vn\ K_2}{Pn}\right)}{310.} \times 100 \text{ or } \frac{Vn\ K_2}{Pn(310.)} \times 100$$

where I_3 is the intensity rating based on the ratio of value added by manufacture to total population, Vn, K_2 and Pn are as defined above, and 310 is the fixed base for this criterion.

The multiple-criteria intensity rating then may be expressed as

$$I_m = \frac{I_1 + I_2 + I_3}{3}.$$

Ten intensity classes have been arbitrarily established and given Roman numeral designations I to X as follows:

Class	*Intensity Rating*
I	Over 200
II	175 to 199
III	150 to 174

Class		*Intensity Rating*
IV	....	125 to 149
V	....	100 to 124
VI	....	75 to 99
VII	....	50 to 74
VIII	....	25 to 49
IX	....	12 to 24
X	....	Less than 12

MANUFACTURING MAGNITUDE AND INTENSITY OF THE PITTSBURGH STANDARD METROPOLITAN AREA, KING COUNTY, WASHINGTON,[8] AND THE STATE OF TEXAS

The multiple-criteria method for magnitude and intensity measurement does provide answers to the questions raised at the outset of this paper. The quantity and importance of manufacturing in the Pittsburgh Standard Metropolitan Area, King County, Washington, and the state of Texas can be ascertained by the method, and the three areas can be quantitatively compared. Calculations are shown below for the year 1947.[9]

Magnitude, Pittsburgh Standard Metropolitan Area

$$M_1 = \frac{337{,}974}{70{,}000} \times 100 = 482.8$$

$$M_2 = \frac{1{,}023{,}913{,}000(K_1)}{100{,}000{,}000} \times 100 = \frac{540{,}893{,}000}{100{,}000{,}000} \times 100 = 540.9$$

$$M_3 = \frac{1{,}707{,}918{,}000(K_2)}{200{,}000{,}000} \times 100 = \frac{1{,}014{,}232{,}000}{200{,}000{,}000} \times 100 = 507.1$$

$$M_m = \frac{482.8 + 540.9 + 507.1}{3} = 510.3\text{—Class C}$$

Magnitude, King County, Washington

$$M_1 = \frac{54{,}770}{70{,}000} \times 100 = 78.2$$

$$M_2 = \frac{171{,}221{,}000(K_1)}{100{,}000{,}000} \times 100 = \frac{90{,}450{,}000}{100{,}000{,}000} \times 100 = 90.5$$

$$M_3 = \frac{265{,}422{,}000(K_2)}{200{,}000{,}000} \times 100 = \frac{135{,}293{,}000}{200{,}000{,}000} \times 100 = 67.6$$

$$M_m = \frac{78.2 + 90.5 + 67.6}{3} = 78.8\text{—Class F}$$

[8] King County and the Seattle Standard Metropolitan Area shown in Tables I and II are the same.

[9] K_3 is derived from application of wholesale price indexes to each major industry group as referred to in footnote 6.

Magnitude, State of Texas

$$M_1 = \frac{297{,}053}{70{,}000} \times 100 = \qquad 424.4$$

$$M_2 = \frac{775{,}411{,}000(K_1)}{100{,}000{,}000} \times 100 = \frac{409{,}620{,}000}{100{,}000{,}000} \times 100 = 409.6$$

$$M_3 = \frac{1{,}727{,}464{,}000(K_2)}{200{,}000{,}000} \times 100 = \frac{883{,}679{,}000}{200{,}000{,}000} \times 100 = 441.8$$

$$M_m = \frac{424.4 + 409.6 + 441.8}{3} = 425.3\text{—Class C}$$

Intensity, Pittsburgh Standard Metropolitan Area

$$I_1 = \frac{337{,}974}{764{,}900(.300)} \times 100 = \qquad 147.3$$

$$I_2 = \frac{337{,}974}{2{,}174{,}000(.110)} \times 100 = \qquad 141.3$$

$$I_3 = \frac{1{,}707{,}918{,}000(K_2)}{2{,}174{,}000(310.)} \times 100 = \frac{1{,}014{,}232{,}000}{2{,}174{,}000(310.)} \times 100 = 150.6$$

$$I_m = \frac{147.3 + 141.3 + 150.6}{3} = 146.6\text{—Class IV}$$

Intensity, King County, Washington

$$I_1 = \frac{54{,}770}{255{,}000(.300)} \times 100 = \qquad 71.7$$

$$I_2 = \frac{54{,}770}{664{,}600(.110)} \times 100 = \qquad 74.9$$

$$I_3 = \frac{265{,}422{,}000(K_2)}{664{,}600(310.)} \times 100 = \frac{135{,}293{,}000}{664{,}600(310.)} \times 100 = 65.7$$

$$I_m = \frac{71.7 + 74.9 + 65.7}{3} = 70.8\text{—Class VII}$$

Intensity, State of Texas

$$I_1 = \frac{297{,}053}{2{,}572{,}000(.300)} \times 100 = \qquad 38.5$$

$$I_2 = \frac{297{,}053}{7{,}322{,}300(.110)} \times 100 = \qquad 36.9$$

$$I_3 = \frac{1{,}727{,}464{,}000(K_2)}{7{,}322{,}300(310.)} \times 100 = \frac{883{,}679{,}000}{7{,}322{,}300(310.)} \times 100 = 39.1$$

$$I_m = \frac{38.5 + 36.9 + 39.1}{3} = 38.2\text{—Class VIII}$$

The figures above show that the Pittsburgh Metropolitan Area has a magnitude rating of 510 and an intensity rating of 146. It might be referred to by class only

as a C-IV area. King County, Washington, on the other hand has a magnitude rating of only 15 percent that of Pittsburgh, and an intensity rating about half as large. It is an F-VII area. The magnitude ratings show that the state of Texas has 83 percent as much manufacturing as the Pittsburgh Standard Metropolitan Area, but because of its large size and many non-manufactural activities, the intensity rating is relatively low. Texas has a class designation of C-VIII.

APPLICATION OF THE MULTIPLE-CRITERIA METHOD TO LEADING STANDARD METROPOLITAN AREAS OF THE UNITED STATES

The multiple-criteria method was applied to the fifty-three Standard Metropolitan Areas in the United States which in 1947 had over 40,000 people employed in manufacturing. Calculations were made for both 1939 and 1947, the last two years for which there are complete censuses of manufactures. The results are shown on Tables I and II and generalized on maps by class in Figures V and VI. Figures I, II, III, and IV show rank of the areas, individual criteria ratings, and the spread between the ratings.

Magnitude Rank, 1947

In 1947 only one of the fifty-three Standard Metropolitan Areas fell within magnitude class A. That was New York-Northeastern New Jersey, with a rating of 2424. The New York area is generally recognized as the world's greatest commercial center, but often its pre-eminence in manufacturing is overlooked. It is 60 percent larger than Chicago, its nearest rival among the Standard Metropolitan Areas. Both Chicago and Detroit fell into class B in 1947, although Chicago with a rating of 1488 was near the top of the class and Detroit with a rating of 866 was near the bottom.

Four Standard Metropolitan Areas—Philadelphia (783), Los Angeles (561), Pittsburgh (510), and Cleveland (431)—have class C magnitudes. Class D is represented by eight areas, ranging from Boston, the largest, to Cincinnati, the smallest; Class E by twelve areas, and Class F by 26 areas.

Increase in Magnitude, 1939–47

The growth rates between 1939 and 1947 were large and mirror the change which took place during World War II. The Los Angeles and Houston Standard Metropolitan Areas experienced the greatest growth during this period, with magnitude increases of 120 and 116 percent, respectively. They were followed by Louisville (102 percent), Grand Rapids (100 percent), and Portland, Ore. (95 percent). Reading experienced the smallest growth with a gain of only 30 percent. Others with small increases were Wheeling-Steubenville (33 percent), Allentown-Bethlehem-Easton (34 percent), Fall River-New Bedford (36 percent), Flint (37 percent), and Worcester (39 percent).

Exceptional gains in some areas resulted in changes in magnitude rank among the Standard Metropolitan Areas. Several areas moved up or down in rank as

much as eight or ten places. The examples below illustrate this unevenness of industrial growth and change in rank between 1939 and 1947:

Standard Metropolitan Area	*1939*		*1947*	
	Magnitude	*Rank*	*Magnitude*	*Rank*
Boston	267	6	391	8
Los Angeles	255	7	561	5
Reading	54	33	70	42
Portland, Ore.	40	43	78	36
Rochester	102	17	150	19
Minneapolis-St. Paul	98	18	181	16

Trends in regional assembly and processing costs, changing geography of markets, types of products produced in particular areas, vigor of areal promotional campaigns, and many other factors lie behind this variation in manufactural growth. With some exceptions large increases in magnitude were experienced by the new manufacturing areas of the West and South, while smaller growth characterized the New England-New York-Pennsylvania region. This of course, should not be misconstrued to mean that the West and South generally had larger absolute increases than the Northeast. The growth trends of the 1939-47 period have tended to continue on through 1952 in most of the recent cases studied by this method.

Intensity Rank, 1947

Of the fifty-three Standard Metropolitan Areas, New Britain-Bristol ranked number one in intensity in 1947 with a rating of 277. In 1947, 32 percent of the population there was directly employed in manufacturing and 79 percent of the gainfully employed worked for manufacturing concerns. New Britain-Bristol was followed by Waterbury, with an intensity rating of 259, Bridgeport with 254, Akron with 244, Dayton and South Bend with 205 each, Youngstown with 203, and Flint with 201. All of these were Class I areas.

New Orleans, with a rating of 60, had the lowest intensity of all the Standard Metropolitan Areas studied and was in Class VII. Other class VII areas were Atlanta (65), Seattle (71), and Portland, Ore. (74). In addition to class I and VII areas listed above, there were ten areas in class II, twelve in class III, eight in class IV, six in class V, and five in class VI.

Low intensity ratings of newer manufacturing areas in the South and West, and relatively higher ones in the old northeastern section of the country are as expected. The logically low intensity in such great commercial centers as New York-Northeastern New Jersey (115) and Boston (106) too, is clearly brought out.

Increase in Intensity, 1939–47

The Standard Metropolitan Areas varied considerably in increase in intensity between 1939 and 1947. Toledo, Grand Rapids, Milwaukee, Syracuse, Akron,

TABLE I

MAGNITUDE RATINGS OF LEADING STANDARD METROPOLITAN AREAS, 1939 AND 1947

Standard Metropolitan Area	1939			1947*				Percent increase 1939–47**
	Rating	Rank	Class	Method 1	Method 2	Rank	Class	
Akron	85	20	F	137	154	18	E	81
Albany-Schenectady-Troy	66	24	F	99	99	28	F	50
Allentown-Bethlehem-Easton	86	19	F	114	115	23	E	34
Atlanta	39	44	G	65	62	49	F	59
Baltimore	174	11	E	249	252	13	D	45
Birmington	46	36	G	75	77	37	F	67
Boston	267	6	D	389	391	8	D	46
Bridgeport	55	32	F	101	102	27	E	85
Buffalo	182	10	E	280	283	10	D	55
Canton	50	35	F	80	82	32	F	64
Chicago	920	2	B	1485	1488	2	B	62
Cincinnati	124	15	E	203	203	15	D	64
Cleveland	236	8	D	423	431	7	C	83
Columbus	42	40	G	79	79	34	F	88
Dayton	80	21	F	145	146	20	E	83
Detroit	581	3	C	857	866	3	B	49
Erie	36	48	G	66	66	46	F	83
Fall River-New Bedford	56	30	F	77	76	39	F	36
Flint	63	26	F	86	86	31	F	37
Grand Rapids	37	46	G	73	74	41	F	100
Hartford	58	27	F	91	91	30	F	57
Houston	45	37	G	95	97	29	F	116
Indianapolis	72	23	F	138	138	21	E	92
Kansas City	73	22	F	119	118	22	E	62
Los Angeles	255	7	D	556	561	5	C	120
Louisville	56	30	F	114	113	24	E	102
Milwaukee	142	13	E	268	266	11	D	87
Minneapolis-St. Paul	98	18	F	183	181	16	E	85
New Britain-Bristol	37	46	G	64	65	47	F	76
New Haven	36	48	G	57	58	51	F	61
New Orleans	36	48	G	61	58	51	F	61
New York-Northeastern-New Jersey	1602	1	A	2488	2424	1	A	51
Peoria	36	48	G	68	66	45	F	83
Philadelphia	545	4	C	780	783	4	C	42
Pittsburgh	335	5	D	498	510	6	C	52
Portland, Ore.	40	43	G	81	78	36	F	95
Providence	130	14	E	205	204	14	D	57
Reading	54	33	F	71	70	42	F	30
Rochester	102	17	E	151	150	19	E	47
San Francisco-Oakland	164	12	E	267	266	11	D	62
Seattle	41	42	G	81	79	34	F	93
South Bend	36	48	G	68	68	44	F	89
Springfield-Holyoke	64	25	F	114	113	24	E	77
St. Louis	230	9	D	353	352	9	D	53
Syracuse	42	40	G	79	80	33	F	90
Toledo	57	29	F	108	109	26	E	91
Trenton	38	45	G	58	61	50	F	61
Utica-Rome	44	38	G	70	70	42	F	59
Waterbury	44	38	G	62	64	48	F	45
Wheeling-Steubenville	58	27	F	74	77	37	F	33
Worcester	54	33	F	75	75	40	F	39
York	35	53	G	55	55	53	F	57
Youngstown	103	16	E	162	169	17	E	64

* The two rating methods used here are explained in footnote 6. In method 1, the 1947 value-added figures were deflated through use of the wholesale price index for "Manufactured Products." In method 2, the 1947 value-added figures were deflated through application of the appropriate individual indexes to each industry group.

** Based on rating method 2.

TABLE II

INTENSITY RATINGS OF LEADING STANDARD METROPOLITAN AREAS, 1939 AND 1947

Metropolitan Area	1939			1947*				Percent increase 1939–47**
	Rating	Rank	Class	Method 1	Method 2	Rank	Class	
Akron	152	6	III	216	244	4	I	61
Albany-Schenectady-Troy	88	39	VI	121	121	40	V	38
Allentown-Bethlehem-Easton	146	8	IV	171	172	19	III	18
Atlanta	52	49	VII	68	65	52	VII	25
Baltimore	102	33	V	121	123	39	V	21
Birmingham	69	44	VII	93	96	45	VI	39
Boston	79	42	VI	106	106	42	V	34
Bridgeport	169	3	III	251	254	3	I	50
Buffalo	120	21	V	162	164	25	III	37
Canton	136	16	IV	186	190	11	II	41
Chicago	116	22	V	163	164	25	III	41
Cincinnati	101	35	V	145	145	33	IV	44
Cleveland	114	25	V	175	179	16	II	57
Columbus	71	43	VII	104	104	43	V	46
Dayton	146	8	IV	204	205	5	I	40
Detroit	144	10	IV	177	179	16	II	24
Erie	140	13	IV	197	195	9	II	39
Fall River-New Bedford	155	5	III	186	184	13	II	19
Flint	164	4	III	201	201	8	I	23
Grand Rapids	100	36	V	161	163	27	III	63
Hartford	122	20	V	157	157	29	III	29
Houston	51	50	VII	78	80	48	VI	57
Indianapolis	98	37	VI	156	156	30	III	59
Kansas City	68	45	VII	94	93	46	VI	37
Los Angeles	55	48	VII	85	86	47	VI	56
Louisville	84	41	VI	135	134	38	IV	60
Milwaukee	116	22	V	190	188	12	II	62
Minneapolis-St. Paul	65	47	VII	105	104	43	V	60
New Britain-Bristol	194	2	II	272	277	1	I	43
New Haven	103	32	V	138	141	34	IV	37
New Orleans	48	53	VIII	63	60	53	VII	25
New York-Northeastern-New Jersey	86	40	VI	118	115	41	V	34
Peoria	106	29	V	174	169	24	III	59
Philadelphia	110	27	V	136	137	36	IV	25
Pittsburgh	105	30	V	143	147	32	IV	40
Portland, Ore.	51	50	VII	76	74	50	VII	45
Providence	133	18	IV	182	182	14	II	37
Reading	149	7	IV	174	172	19	III	15
Rochester	142	11	IV	192	191	10	II	35
San Francisco-Oakland	67	46	VII	79	79	49	VI	18
Seattle	51	50	VII	72	71	51	VII	39
South Bend	138	15	IV	205	205	5	I	49
Springfield-Holyoke	114	25	V	177	175	18	II	54
St. Louis	102	33	V	137	137	36	IV	34
Syracuse	92	38	VI	148	149	31	IV	62
Toledo	104	31	V	169	171	22	III	64
Trenton	124	19	V	161	170	23	III	37
Utica-Rome	115	24	V	158	159	28	III	38
Waterbury	207	1	I	249	259	2	I	25
Wheeling-Steubenville	110	27	V	133	138	35	IV	25
Worcester	135	17	IV	172	172	19	III	27
York	140	13	IV	181	182	14	II	30
Youngstown	141	12	IV	194	203	7	I	44

* The two rating methods used here are explained in footnote 6. In method 1, the 1947 value-added figures were deflated through use of the wholesale price index for "Manufactured Products." In method 2, the 1947 value-added figures were deflated through application of the appropriate individual indexes to each industry group.

** Based on rating method 2.

Minneapolis-St. Paul, and Louisville all experienced gains of 60 percent or slightly more. On the other hand, Reading grew only 15 percent, and Allentown-Bethlehem-Easton, San Francisco-Oakland, and Fall River-New Bedford had increases of less than 20 percent.

Numerous changes in intensity rank occurred. Among the leaders, New Britain-Bristol displaced Waterbury as number 1, and Akron moved from sixth to fourth place. The examples below illustrate the unevenness in intensity growth and change in rank between 1939 and 1947:

Standard Metropolitan Area	*1939*		*1947*	
	Intensity	*Rank*	*Intensity*	*Rank*
Fall River-New Bedford ...	155	5	184	13
Youngstown	141	12	203	7
Philadelphia	110	27	137	36
Syracuse	92	38	149	31
Flint	164	4	201	8
Akron	152	6	244	4

A large intensity increase may mean either an exceptional magnitude gain, or a relatively small increase in other activities or in population. A number of the areas which experienced low intensity gains actually had great increases in magnitude, but gains in commerce, agriculture, population, etc., were also so great in these areas that the resulting ratings showed only meager intensity increases between 1939 and 1947.

Relative Variations in Individual Criteria Ratings in Standard Metropolitan Areas

Application of the multiple-criteria method to the Standard Metropolitan Areas brought out interesting variations in individual criteria ratings. Figures I, II, III, and IV show both the multiple-criteria ratings and the individual criteria ratings for 1939 and 1947. The light upper portion of each bar represents the spread between the highest and the lowest ratings. No attempt is made here to analyze the individual criteria ratings in terms of their variations from each other or in terms of their deviations from the multiple-criteria ratings. Indeed this is another problem. A few cases, however, might be cited as illustrations of the nature of these variations and the possibilities of analysis they offer.

In some sections of the United States, the Standard Metropolitan Areas were characterized by one magnitude criterion rating which was consistently higher than another. New England areas, with very few exceptions, were characterized by high salaries-and-wages ratings and relatively low value-added-by-manufacture ratings. The reverse was fairly consistently true for the areas of southern United States. Perhaps this can be explained by the South's lower wage scales,

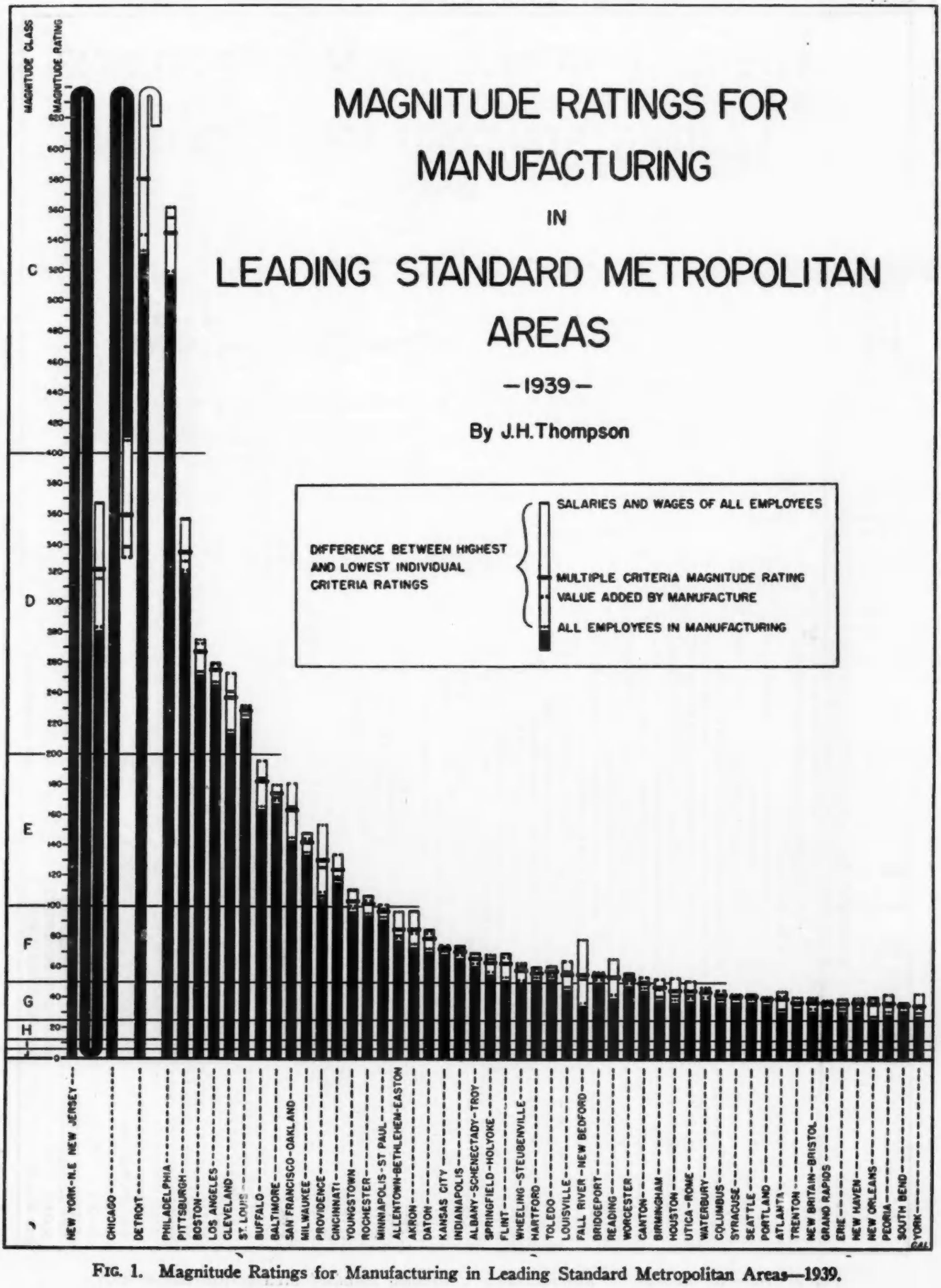

FIG. 1. Magnitude Ratings for Manufacturing in Leading Standard Metropolitan Areas—1939.

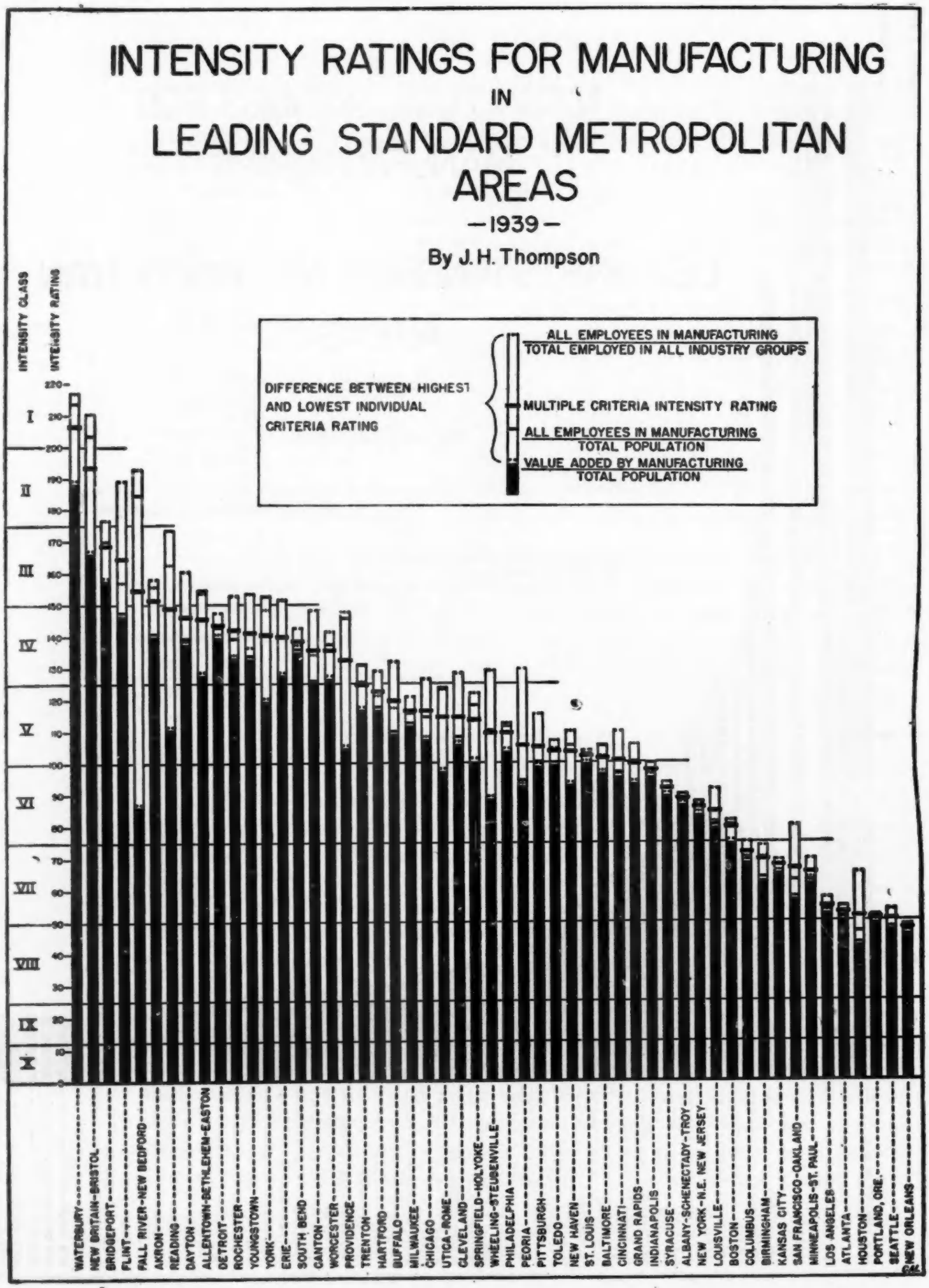

FIG. 2. Intensity Ratings for Manufacturing in Leading Standard Metropolitan Areas—1939.

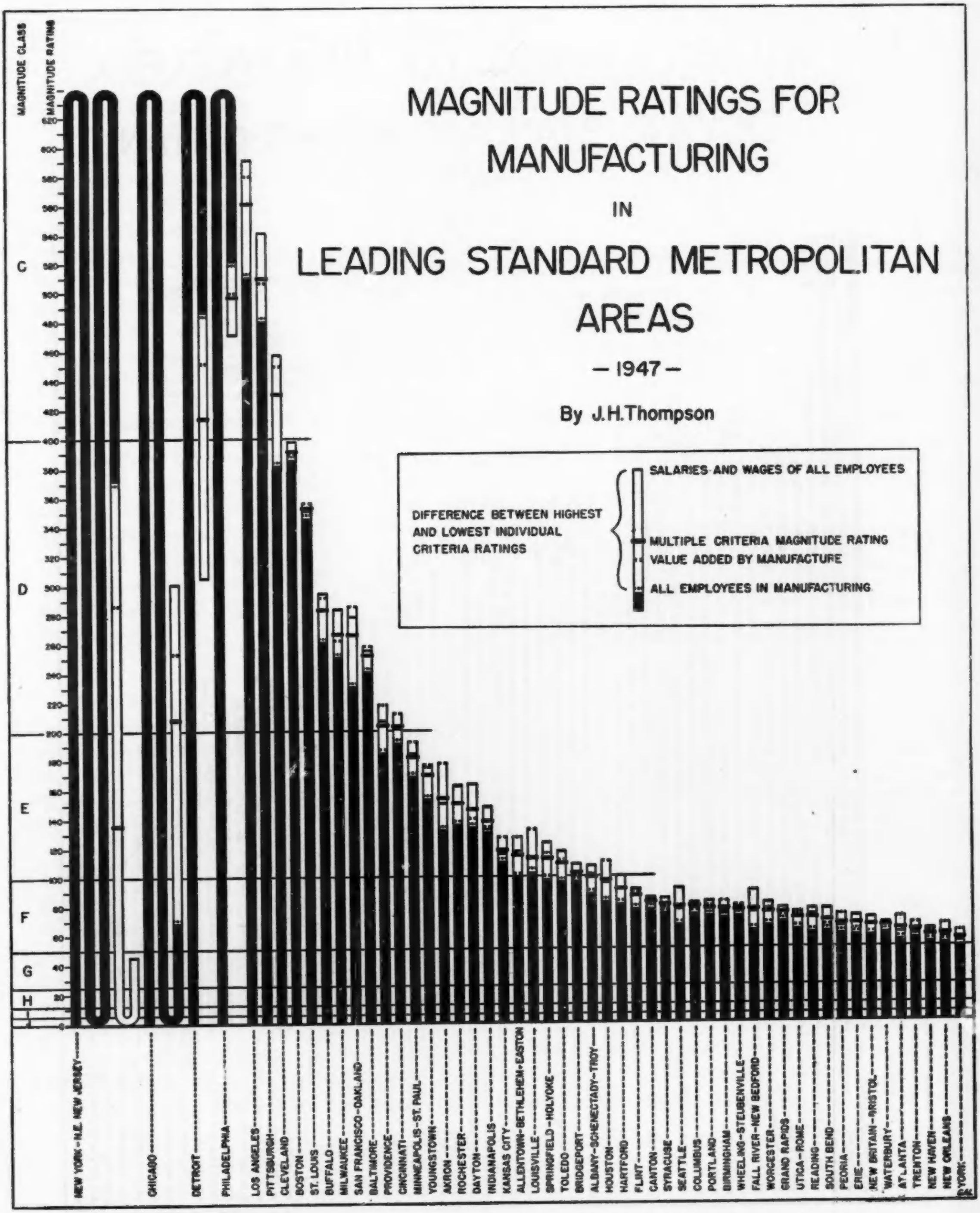

FIG. 3. Magnitude Ratings for Manufacturing in Leading Standard Metropolitan Areas—1947.

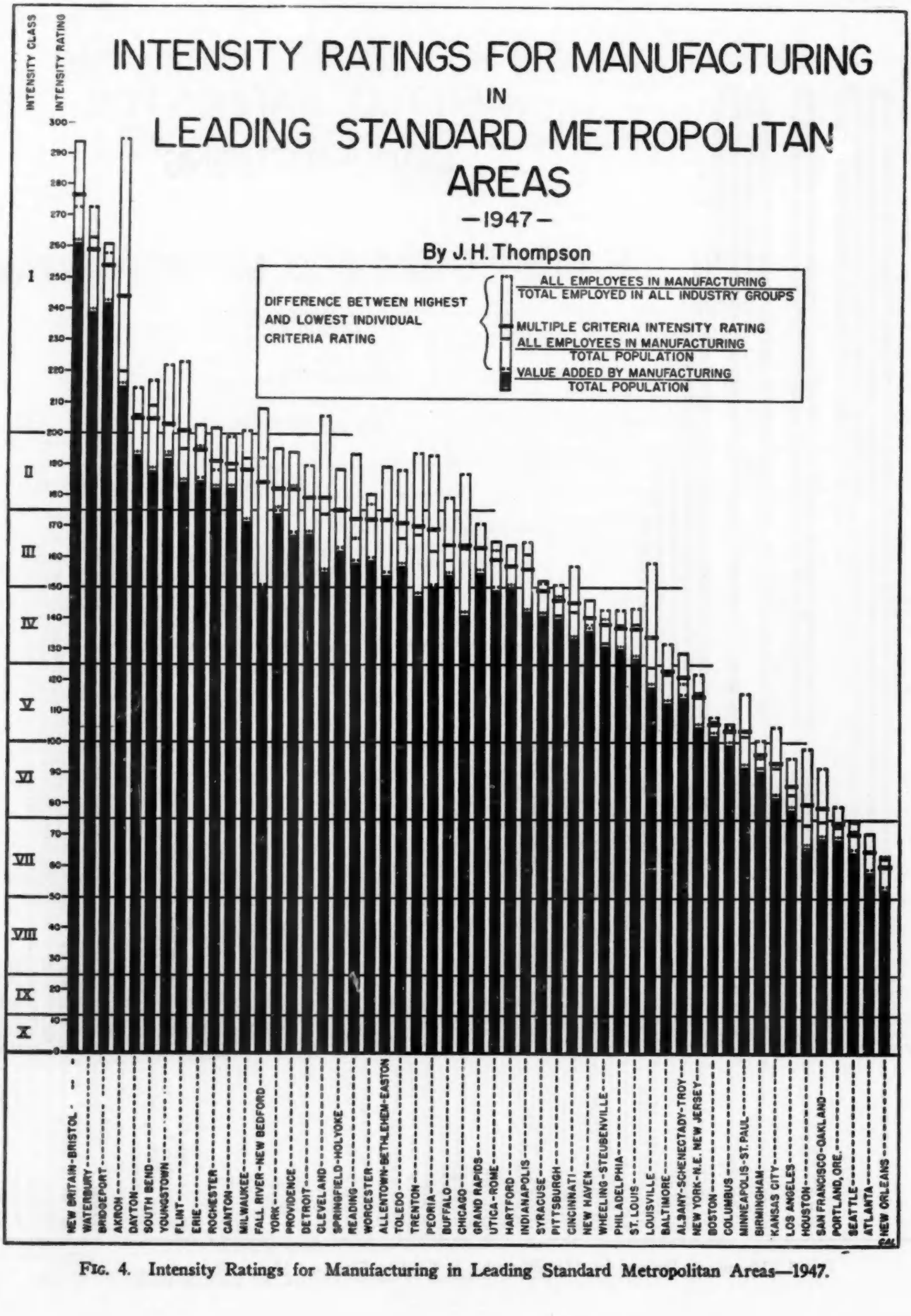

FIG. 4. Intensity Ratings for Manufacturing in Leading Standard Metropolitan Areas—1947.

generally newer equipment, and larger percentage of industries which result in a high value added per worker.

A comparison of the salaries-and-wages magnitude ratings of 1939 and 1947 reveals a striking relative increase in value during that period. In 1939 this criterion ranked highest of the three criteria in seventeen areas, and lowest in eleven. In 1947 it ranked highest in thirty-two and lowest in but two. The all-employees-in-manufacturing criterion experienced a reverse trend. In 1939 it ranked highest in twenty-three cases and lowest in twenty-two, but in 1947 it was highest in seven and lowest in thirty-one. Such trends reflect relatively rapid increases in labor costs and improvement of equipment and techniques. Because the variations in individual criteria ratings are uniform neither in space nor in time, the calculation of such ratings may provide useful raw material for areal differentiation and trend analysis.

REPRESENTATION OF THE MULTIPLE-CRITERIA RATINGS ON MAPS

Magnitude and intensity ratings are readily transferable to maps. Figures V and VI illustrate one way in which they may be represented. On these maps the areas of the circles are proportionate to the mid-values of the magnitude classes, and the patterns within the circles indicate the intensity. A similar procedure could be followed for states, counties, or any other areas, domestic or foreign, for which statistics are available. Magnitude or intensity units (an area with a magnitude rating of 100 magnitude units) too are readily transferable to maps in the form of dots.

SUMMARY

Areal differentiation of manufacturing activity depends to an important extent on the measurement of the activity. A measurement by one criterion only does not always provide a satisfactory base for areal differentiation. This is particularly true when areas with different techniques, economies, or types of industries are involved. A measurement which takes into account several criteria is likely to be more realistic and offers more possibilities for analysis.

This paper has presented a multiple-criteria method for the measurement of two aspects of manufacturing, magnitude and intensity. Magnitude, as used, means quantity of manufacturing, and intensity refers to the importance of manufacturing in the economy. Magnitude calculations require three kinds of statistics: (1) all employees in manufacturing, (2) salaries and wages, and (3) value added by manufacture. Intensity calculations require four kinds of data: (1) all employees in manufacturing, (2) total employed in all industry groups, (3) value added by manufacture, and (4) population.

The resulting measurements facilitate quantitative comparisons of any areas for which the required statistics are available, and they provide suitable measurements for trend or time studies in one area. Because they employ several criteria,

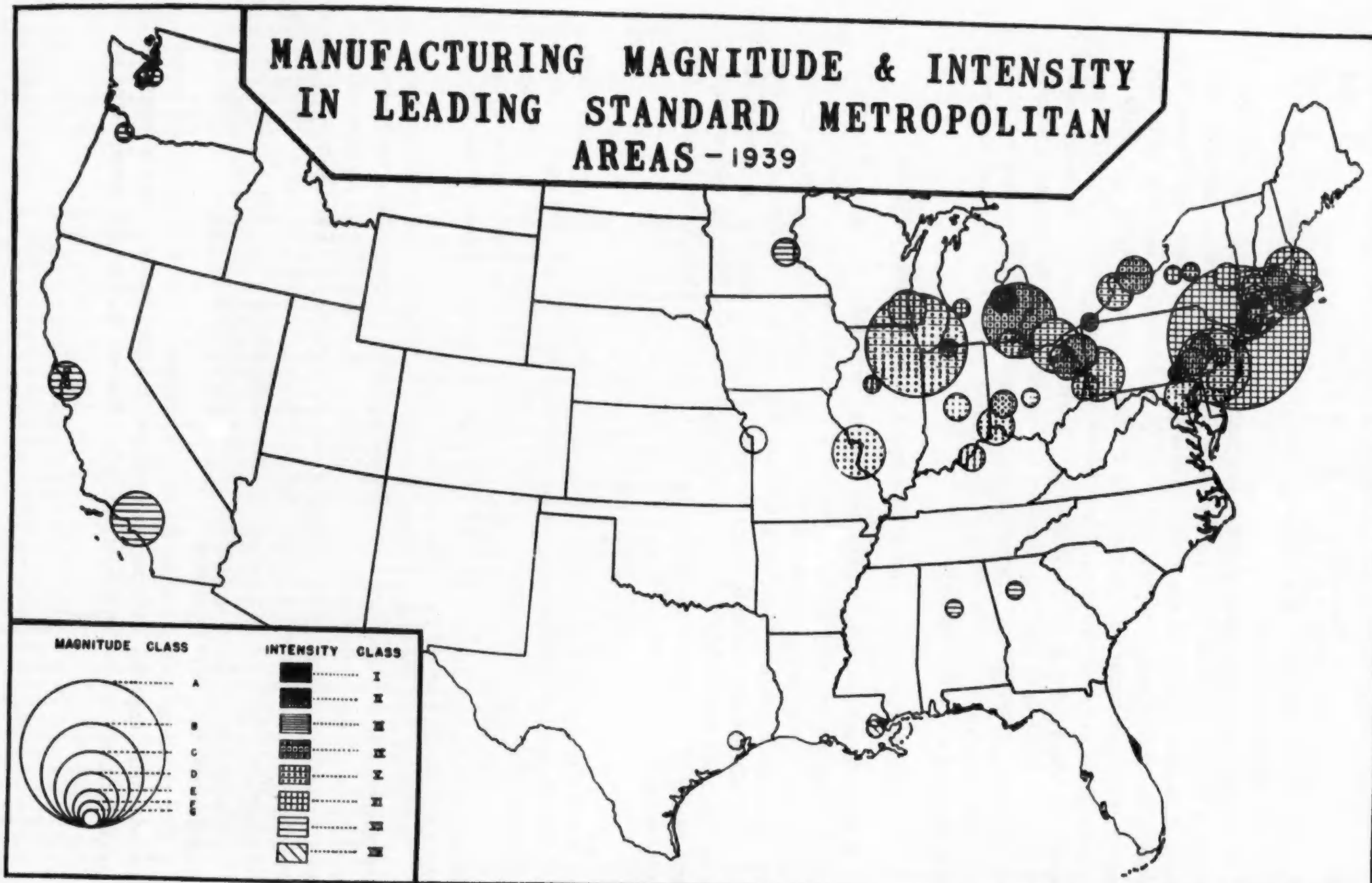

Fig. 5. Manufacturing Magnitude and Intensity in Leading Standard Metropolitan Areas—1939.

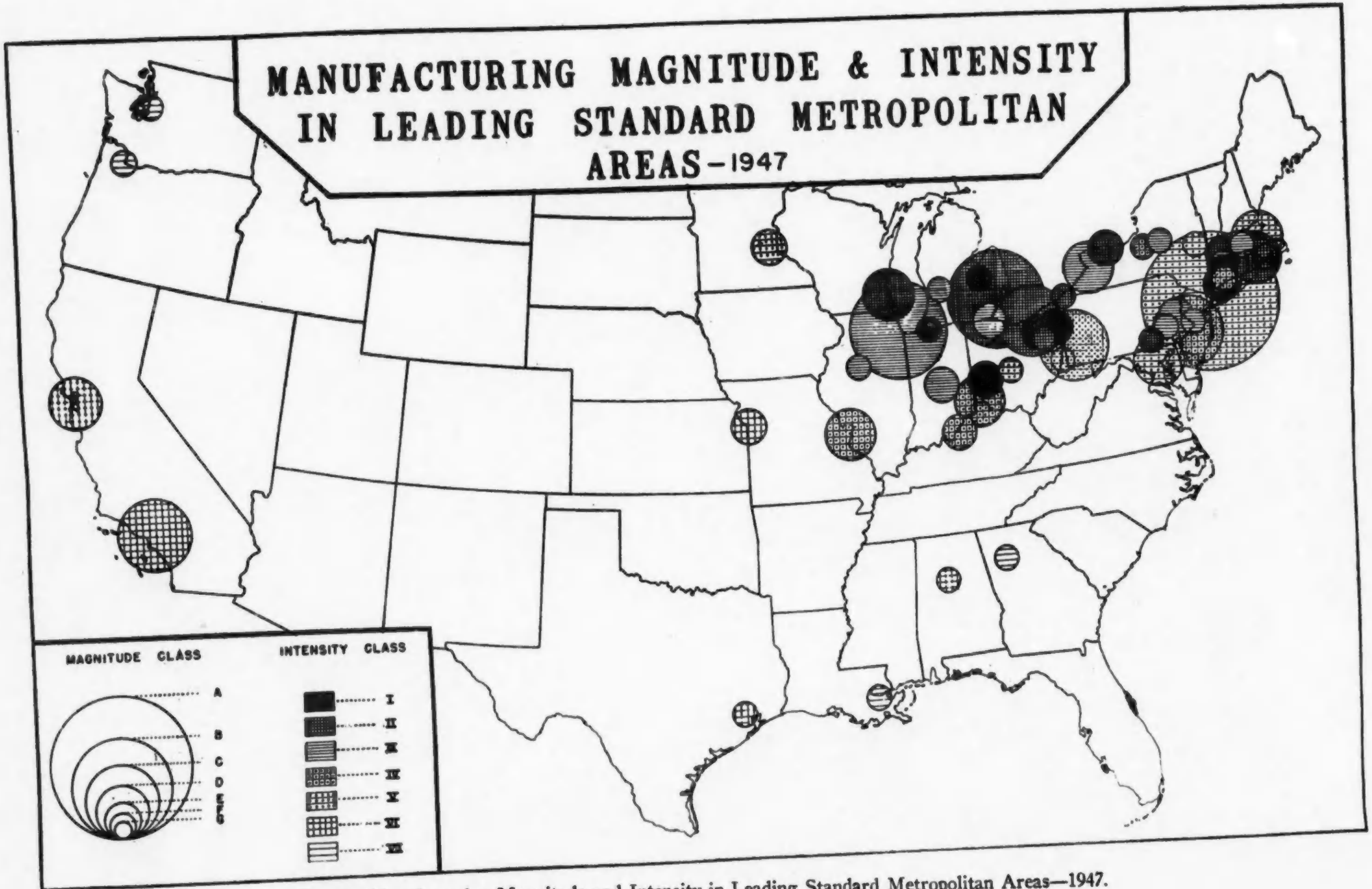

FIG. 6. Manufacturing Magnitude and Intensity in Leading Standard Metropolitan Areas—1947.

each criterion can be analyzed in relation to the others used or in relation to the multiple-criteria measurement.

The mapping of magnitude and intensity as calculated by this method could conceivably provide a deeper insight into the geography of an area like the American Manufacturing Belt. It might also assist in the establishment of a hierarchy of manufacturing concentrations, and help systematize descriptions of manufacturing areas.

THE ASSOCIATION AND THE ANNALS

The Association of American Geographers was formally organized in Philadelphia on December 29, 1904, following plans earlier reached at meetings of the American Association for the Advancement of Science, and the Eighth International Geographical Congress. Leading objectives of the Association are the encouragement of original research and the publication of studies in geography and related fields.

The ANNALS was instituted in 1911 to stimulate scholarship and to provide a medium for the exchange of findings. Its volumes contain professional work of members and other contributors, presidential addresses and abstracts of papers delivered at annual meetings, occasional committee reports of general interest or importance, and symposia on topical and regional themes.

The September and December numbers of 1939 (Vol. XXIX) comprised Richard Hartshorne's monograph, "The Nature of Geography," a significant work which was later reissued as one volume. Continued demand has exhausted a second printing (1946) and a third printing (1949). A fourth printing is now available (Sept. 1951) at A. A. G. Central Office, Map Division, Library of Congress, Washington 25, D. C.

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